DX32 CNC

Operators Manual

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TABLE OF CONTENTS

SECTION PAGE

Chapter 1

Getting Started 3
- Basic Hardware 5
- Operator's Console 5
- Basic BOSS DX32 Software 6
- DOS System Commands 7
- Setting Up The PC SX System Configuration 9
- DX32 Modes of Operation 10
- Run Mode 10
- DX Screen Configuration 11

Chapter 2

System Start-Up / Shutdown 13
- Axis Drive Start Up Procedure 14
- Normal Shutdown Procedure 15
- Emergency Stop Shutdown 15
- Load Remote 16
- Files 17

Chapter 3

Basic Operation 19
- Basic Operation Screen Display 19
- Basic Operation 21
- Jog Axis Modes 22
- Special Functions 25
- Teach Mode 28

Chapter 4

Set Up 31
- Set-Up Screen Display 31
- DX32 Coordinate Systems 32
- Jogging the Axes 33
- Tool Length Offsets 34
- Cutter Diameter Compensation 35
- Filing and Loading Part Programs 36

Chapter 5

Run 39
- Run Screen Display 39
- Normal Operation 41
- Feed Override 43
- Run Options 43

Chapter 6

Edit/MDI 45
Commands for Editing Text 45
Using the G-Code Prompt Mode 47

APPENDIX A

Remote Load and DNC Protocols 49
Establishing Communications 49
Transfer Record Structure 49
Suspension/ Resumption of Transmission 50
Error Handling 50

INTRODUCTION
to the
BRIDGEPORT DX32

ABOUT THIS MANUAL

This manual provides detailed information and procedures for setting up and operating the Bridgeport DX32 Computerized Numerical Control. The DX32 CNC combines the advanced part-programming ability of the Bridgeport BOSS 9 and BOSS 10 controls with a PC AT based user interface, providing even more sophisticated capabilities. The DX32 is more powerful than ever, and its user-friendly screen displays make it easier to learn and use than previous CNC systems.

Updates and enhancements to the BOSS XT Operating System are entirely loadable from computer disk. This feature prevents the DX32 from quickly becoming obsolete. The completely re-programmable DOS-based PC technology provides a springboard into the future, much more so than the Application Specific Design that is now prevalent in today's CNCs.

What is included in this manual:

Chapter 1 **Getting Started**, provides a brief overview of the parts of the DX32, describes what each does, and reveals how the system hardware and software run together. Also included are instructions on setting up the DX32 for operation.

Chapter 2 **System Start-Up/Shut-Down**, describes the system start-up and shut-down procedures.

Chapter 3 **BASIC OPERATION**, describes the most frequently used commands.

Chapter 4 **SET-UP**, describes how to set-up the part for subsequent machining.

Chapter 5 **RUN**, describes the various Run options.

Chapter 6 **EDIT/MDI**, summarizes the commands available for editing part-program text.

Chapter 1
Getting Started

This chapter describes how to get started with the DX32 CNC.

Included in this chapter is:

- A brief overview of the parts of the DX32
- A description of what each part does and how the system hardware and software function together.
- A detailed procedure describing how to set-up the DX32 for operation.

General Description

The DX32 Control integrates a PC AT single board computer and a BOSS 10 (Bridgeport Operating System Software) CNC control. The PC AT DOS-based computer combines full-feature capability with ease of use such as VGA color graphics and multiple windows to prompt the user through all control functions. The various machine functions are selected with the numeric keypad and function keys on the keyboard. The keys required to perform the necessary operator functions are linked to a color-coded, on-screen display.

An On-Screen Editor incorporates a unique G-code conversational mode that prompts the operator for the information required to execute a machine command. User-selectable HELP screens provide detailed information about the G-code being input. The editor provides an immediate MDI mode to execute a programmed block of data after it is formatted on the screen. The DX32 features an extensive selection of canned cycles allowing easy execution of frequently used cycles including bolt circles, multi-hole row/frame drilling, and slot, frame and pocket milling, with only a single block of programmed data.

The control includes all the standard high performance features associated with the BOSS 9 and 10 controls:

- 3D Linear, 2D Circular, Helical, and Spiral interpolation.
- XYZ/ Polar/ Spherical Coordinates.
- Cutter compensation with automatic corner-rounding.
- Parametric programming including Algebraic and Trigonometric functions and IF-THEN-ELSE conditional block execution.
- Repetitive programming using looping techniques and MACROs with call-modifiable variables.
- 24,000 characters (200 ft.) of non-volatile part-program storage.
- DNC data transfer between the PC AT based front end and the CNC machine controller which allows programs of unlimited length to be executed either from disk or from an external source.

The control includes a built-in 3.5 inch diskette drive, and a 40 mega-byte hard disk drive. The hard-cased 3.5 inch diskette has a spring-loaded, positive cover over the read area for additional protection in the typical shop environment. Each diskette has a 1.44Mbyte capacity (12000 ft.) A user-friendly DOS Shell enables the user to list file directories and to copy, delete, and rename files and format disks. Communications software is provided to link to remote computer systems such as EZ-CAM via a provided RS-232 interface. A high speed (10Mbaud) Ethernet connection is available for networking.

LEADING DATA

RANGE	inch	metric-mm
Table travel (X)	25	635
Saddle travel (Y)	12	305
Head travel (Z)	5	127
Throat distance	20.9	531
Daylight (min)	5.3	135
Daylight (max)x	21.45	545
TABLE		
Overall Size	42 x 9	1067 x 228
Work Surface	42 x 9	1067 x 228
Max Vertical Load (uniformly distributed)	300 lbs	136 kg
T-slots	3 on 2.5	63.5 centers
SPINDLE		
Motor Rating	3 HP (1.5Kw)	
Tooling	BT-30 for power drawbar	
Speed Range	Std 60-4200 rpm w 1:1 ratio 1 rpm increments	

SPEEDS	inch (IPM)	metric (mm/min)
Feed Rate	.1-250	3-6350
Feed Increment	.1	3
Rapid (X,Y)	250	6350

PERFORMANCE	inch	metric
Positioning accuracy (X,Y,Z)	± .001	.025
Repeatability	± .0008	.02
Input Resolution	.0001	.001
Servo Resolution	.0001	.0025

MACHINE	inch	metric (mm)
Height	98	2487
Floor Area	62 x 60	1626 x 1626
Weight	2920 lbs	1327 kg

POWER	
Electrical Supply	60 Hz, 3 phase 230/460V Std 208 special order
Main Power Breaker	25a/15a per phase
Electrical Rating	6kVa
Pneumatics	11 cfm instantaneous flow

BASIC HARDWARE

The DX32 consists of three separate and coordinated microprocessor-based sub-systems:

PC AT. This is a fully integrated IBM PC AT compatible computer with hardware controllers for a 40 mega-byte hard disk drive, a 3.5 inch 1.44 Mbyte floppy disk drive, a 14" color VGA monitor with 640 x 480 pixel resolution, a 101 key keyboard, and 2 RS232 serial ports (1 connected to the BMDC, 1 available for remote link). The primary purpose of the PC AT is to serve as the user interface for the system. The PC AT runs under the MS-DOS version 5.0 Operating System.

BMDC. This a single board Motorola 68030 microprocessor-based motor drive controller. The BMDC board performs the processing functions that control the positioning of the 4 servo drives for the X, Y, Z, and C axes. The BMDC board also monitors system status and coordinates all machine tool related processes. The BMDC board runs under the DX32 Operating System.

AUF. This is a single board microprocessor-based auxiliary function controller. The AUF provides the conditioned input/output signals that perform various machine related functions such as spindle and coolant control, jogging and spindle speed control. The AUF is connected via internal serial link to the BMDC.

OPERATOR'S CONSOLE

The Operator's Console consists of a pendant mounted VGA Color Monitor, a keyboard, and Console Control Switches. These controls are used to operate all functions of the CNC.

The **VGA Color Monitor** displays the screen menus from which the operator can select control functions.

The **Keyboard** provides the basic means for communicating with the DX32 control. The keys are organized into five groups:

1. Main keyboard that includes all the keys normally found on a typewriter.
2. Numeric keypad which, together with pop-up menus on the screen, is used to select various control functions.
3. Function keys that enable selecting special functions.
4. Screen control keys that enable selecting data from different locations on the screen display, particularly during Edit.
5. Special keys that communicate directly to the operating system.

Console Control Switches:
These control switches are primarily used during the System RUN Mode.

START Switch. Depressing the **START** switch begins operation of the part program at the current line of partprogram text. **START** also resumes execution after an interruption such as PROGRAM STOP or system HOLD.

HOLD key- this key stops part program execution and interrupts axis motion without loss of the program position. All axes decelerate to a smooth stop unless a tapping (G84) cycle is in process. During a tapping cycle the machine motion continues until the end of the cycle.

NOTE: In RAPID TRAVERSE (G0), motion may continue up to 0.2 inches after HOLD is pressed. The active registers are not lost. To continue, use START.

EMERGENCY STOP. This is a red mushroom button which when pressed stops the spindle motor and axes drives. Program execution is terminated and the system is set in the System Start Up mode.

When **EMERGENCY STOP** is pressed, the partprogram and TLOs are not destroyed, but axis position is lost. To recover from **EMERGENCY STOP**, first correct the problem which caused use of the button, next pull out the button, then execute the **AXIS DRIVE ENABLE** sequence which returns each axis to the Home position.

NOTE: The **Emergency Stop** button should be used only when an immediate halt of all motion is absolutely necessary or when safety is threatened. In normal use, the **HOLD** button should be used to interrupt axis motion.

JOG KNOB. This is an incremental pulse generator used for either Jogging an Axis to position or for setting Feed Override. When **SETUP||JOG** is selected, rotating the **JOG KNOB** causes the selected axis to move. There are two selectable jog increments: FAST and SLOW. The incremental pulse encoder attached to the knob has 50 detent positions per revolution.

If **RUN||AUTO** is selected, and **FEED OVR** is **ON**, the **JOG KNOB** changes the value of **Feed Override**. The **F,OVR %** displays in the STATUS window.

JOG +/- pushbutton selector switch. This is a selector switch used for either jogging an axis continuously, in .0001 steps, or for spindlespeed override.

When **SETUP||JOG** is selected, rotating the **JOG +/-** switch and depressing the pushbutton causes the Axis selected from the screen menu to move. There are two selectable jog motions: FAST and SLOW.

BASIC BOSS DX32 SOFTWARE

PC AT. Software used on the PC AT consists of *System Software, Applications Software and User Data*

System Software. System software is the essential collection of programs the DX32 needs before you can use it. The operating system used on the PC AT is **MS-DOS**, Version 5.0. MS-DOS (DOS) is a collection of routines that perform basic tasks such as starting (or booting up) the computer, moving data to and from disks and peripheral devices, and managing and allocating memory space in RAM. The most frequently used DOS System commands are described in this manual. For more information on DOS refer to the *MS-DOS User's Reference Manual.*

DOS is the bottom layer of software used on the AT. In normal operation, it is not necessary to access the DOS level. Upon start-up a routine called AUTOEXEC.BAT automatically loads the DX32 specific applications software. For advanced users DOS can be accessed via the START-UP Menu.

Applications Software. The routines that call the front panel screens and perform the commands selected from the screen menus are contained in a program named BXX.EXE. The software driver which controls axis drive functions, and executes machine instructions is call BMDC.BIN. For information on updating the applications software, see Appendix B at the back of this manual.

User Data. User Data consists of partprograms and tool data. The file extension **.TXT** is appended to partprogram text, **.DAT** is appended to tool data.

BMDC. BOSS DX32 is the Operating System used on the BMDC. Previous Bridgeport CNC systems had BOSS imbedded in RAM. On the DX32, BOSS is loaded into RAM located on the BMDC board.

DX32 SYSTEM DISK

The software described above is stored on 3.5 inch floppy disks. Ordinarily each disk is not write-protected, so that data may be written on the disk by the disk drive, and data may also be read from the disk. Each disk can be write-protected by sliding the small tab at one side of the disk so that the hole is uncovered. This is done to protect the data on the disk. The files on the disk then, can be read by the disk drive, but cannot be deleted, renamed, moved, duplicated, or changed in any way. To *un*-protect the disk, slide the small tab back across the hole.

System software and user data may reside on the same disk; however, this does limit the amount of available space for storing user data on the disk. In this case it is also strongly suggested that backup copies of the system software be kept in a safe place. One alternative to this is to keep the system software and user software and data files on separate disks. In this case, the system software disks should be write-protected, so that their contents is not accidentally erased or changed.

DOS SYSTEM COMMANDS

Typically, it is not necessary to access the DOS command level. Some frequently used DOS commands are listed here in case it is necessary to work from the DOS level. Note that the commands listed below are all typed in at the DOS prompt, either **A>** or **C>** depending on whether the system is run from a floppy disk drive, or a hard disk drive. The DOS level may be accessed by pressing **<9>DOS** at the Start-Up menu. The DOS prompt may also be seen if the system crashes. If this happens, type **RUN** at the DOS prompt.

EXECUTE PROGRAM

To execute an application program, simply type the name of the program at the DOS prompt. Application programs are easily identified by the **.EXE** or **.BAT** file extension in a disk directory. Do not type the file extension when executing a program.

The most frequently used EXECUTE PROGRAM command loads and executes the DX32 system software. The command is:

A> RUN or **C> RUN**

LIST DIRECTORY

This command lists all the files on the chosen disk. To list the root directory on drive A, the first 3.5 inch disk drive, type:

A> DIR A:/P

The modifier **/P** causes one screen page at a time to be displayed. To list the root directory on drive C, the hard disk drive, type C instead of A in the above command.

The following are the BOSS SX files on the **BossXT 308** disk:

DOS	<DIR>	Contains directory of DX32 system routines
COMMAND	COM	DOS commands
CONFIG	SYS	PC AT configuration
AUTOEXEC	BAT	Start-up routine
RUN	BAT	
BXT_GHLP	MSG	HELP text
BXT_GHLP	NDX	HELP routine
BXX.EXE	EXE	PC AT DX32 application program
BMDC	BIN	BMDC BOSS DX32
X-EDIT	BAT	
EZ-MILL	BAT	
ACADMGR	BAT	
DATANET	BAT	
NIGHT308	TXT	DX32 TEST PROGRAM
FERROR	TXT	Servo Drive Adjustment Program

MS-DOS allows the user to organize the files on any disk into directories (and sub—directories). This is called a multi-level directory structure. This allows the user to sub-divide the disk into convenient groups of data.

NOTE: In the file list above there is a directory named DOS. To list the files in this directory, enter: **A> DIR**

COPY a:*.* c:*.*
XCOPY a:*.* c:*.* /s

A:\DOS/P

Alt 92

FORMAT DISK

WARNING!! Formatting a disk destroys all the information previously stored on the disk. Be careful not to re-format the system disk. A back-up, read-only, System disk is provided in case the primary system disk is damaged.

Before information can be loaded onto a disk, the disk needs to be initialized into a format that can store the data. To format a disk type:

A> FORMAT A:

The screen displays the message:

Insert new diskette for drive A:
and strike ENTER when ready.

Follow these instructions. The system then formats the disk. At the conclusion of the process, the system displays the message:

Format complete
1457664 bytes total disk space
1457664 bytes available on disk
Format another (Y/N)?

Enter <N> to exit the FORMAT command.

A 3.5 inch disk can hold 1.44 Mbytes. Some space on each disk is used to keep track of the disk's contents. The space used for this directory depends on how much data is on the disk.

COPY FILES

This command copies a file from one disk to another. For example, to copy the file T20.TXT from the system disk, type:

A> COPY A:T20.TXT B:

The system displays the message:

Insert diskette for drive B: and strike
any key when ready

Insert the target disk (the disk the file is being copied to) into the disk drive and strike any key. After the system finishes copying the file, the screen displays the message:

1 File(s) copied
Insert diskette for drive A: and strike
any key when ready

Return the system disk to the drive and strike any key.

DISK COPY

This command copies an entire disk. This command can be used to create a backup disk that may be used if the original system disk is accidently damaged. To use this command type:

A> DISKCOPY

The screen displays the message:

Insert SOURCE diskette in drive A:
Press any key when ready...

Insert the source disk in drive A. Strike any key. The screen then displays the message:

Copying 80 Tracks

After the source disk is copied, the display reads:

Copying 18 Sectors/Track, 2 sides
Insert TARGET diskette in drive A:
Press any key when ready....

Follow the instructions by putting the target disk in the disk drive.

It is necessary to swap the source and target disks into the drive several more times to complete the diskcopy process. At the completion of DISKCOPY the screen reads

Copy another diskette (Y/N)?

Enter <N> to exit the command.

RE-BOOTING DOS

Sometimes it may be necessary to re-boot the PC AT front end without resetting the entire system. This is useful if the PC locks up. To re-boot, simultaneously depress the three keys **<Cntrl> <Alt> <Delete>**.

The system continues through the boot process until the START-UP SYSTEM menu appears.

SETTING UP THE PC AT SYSTEM CONFIGURATION

Don't confuse setting up the PC AT system configuration with setting up the DX32 system configuration.

The PC AT set-up parameters are configured at the factory. To check or alter the Set-up parameters, simultaneously depress the three keys **<Cntrl> <Alt> <Del>**. This reboots the PC. While the PC is restarting, press the **<Del>** key to execute the **Setup** utility.

Setting the Time and Date

The Time and Date settings can be reset via DOS. Exit the DX32 software, and type the command **TIME** at the DOS prompt. Enter the correct time.

To reset the Date setting, type **DATE** at the DOS prompt. Enter the correct date.

STARTING UP THE DX32 AT POWER UP

The Discovery 300, and 308 machines boot automatically from the standard hard disk contained within the control cabinet. Before turning on the main power disconnect, make sure that the floppy disk drive is empty.

The system runs through its STARTUP diagnostics and then verifies the integrity of the driver code stored in the BMDC RAM. If the driver code has been corrupted, the system prompts the operator to load a new version of the driver code (BXT.HEX, BSX30.HEX, or BSX38.HEX for the V2XT, Discovery 300, or Discovery 308 respectively) from disk to the BMDC. This takes approximately 4 minutes. If the driver code is OK, the STARTUP routine then automatically loads and executes the DOS-based DX32 System Software. The START-UP SYSTEM Menu appears on the screen shortly afterwards.

NOTE: *The Num Lock light on the keyboard MUST be ON for the numeric keys to be enabled. If the light is not on depress [Num Lock].*

To startup the system from a floppy disk (System Disk *only*) put the disk into the disk drive *before* turning on the main power disconnect.

NOTE: *Disks must be mounted in the drive with the disk shutter into the drive and with the disk label facing the back of the machine.*

DX32 MODES OF OPERATION

The DX32 uses one of four basic modes during machine operation. They are **STARTUP**, **BASIC OPERATION**, **SETUP** and **RUN**. The default mode after system initialization is **STARTUP**. The **BASIC OPERATION** menus are automatically displayed after the axis drives are enabled and the axes are homed. The **SETUP** mode is made active by selecting **[F3] SETUP** from the **BASIC** menu. The **RUN** mode is made active by selecting **[F4] RUN** from the **BASIC** menu.

BASIC OPERATION

For simplified operation the BASIC OPERATION menu contain the most frequently used operator commands. In normal operation all the commands necessary to set up and run the DX32 can be selected from this screen.

Less frequently used DX32 commands can be accessed from the BASIC OPERATION menu by accessing the START-UP, SET-UP and RUN menus.

SET-UP MODE

The SET-UP screens prepare the machine for part making. This includes establishing machine reference points, tool characteristics, initial axis positions, and loading part programs.

The EDIT function can be accessed through the SETUP mode.

RUN MODE

This mode runs a part program previously loaded into BMDC RAM either in Automatic or Block mode. RUN mode also works with DNC LINK (Direct Numerical Control).

The MDI function can be accessed in the RUN mode.

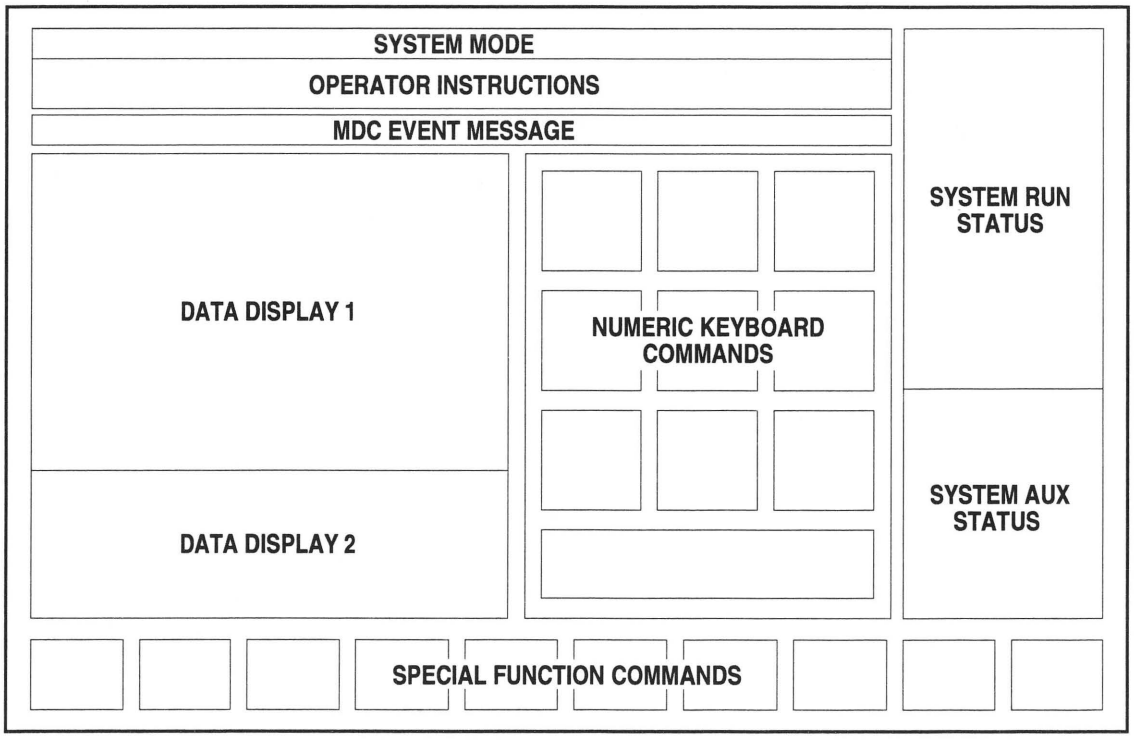
NOTES:

1. The programs BXX.EXE (which run on the PC AT) and BMDC.BIN (which runs on the BMDC) are essentially independent of each other. Status and text data are passed between the two programs as required. This enables concurrent use of the systems. For example, the PC AT can be used to edit a program while the BMDC is machining a part, or the PC AT can be in System Terminal Mode monitoring the servo performance while the BMDC is running diagnostic moves.

2. There are DOS level errors that can stop execution of BXX.EXE. The most frequent error occurs when no disk or an improper disk is mounted in the disk drive. DOS flags the error and breaks to the DOS system level. To resume operation type **RUN** when the DOS prompt **A>** appears.

DX32 SCREEN CONFIGURATION

The DX32 screen contains the fields shown in the illustration below:



Although the initial reaction to the SX display may be that the screen looks cluttered with data, the screens are actually set-up in a consistent, informative manner. The object is to present as much information as possible without requiring the operator to access additional layers of data.

The Screen Display consists of the following windows:

SYSTEM MODE. This is a 1 line status message which displays the System MODE. A real-time clock is also displayed on this line.

OPERATOR INSTRUCTIONS. This is a two line message containing information for the operator. A blinking arrow at the top right hand side of the window indicates when operator input is required.

NOTE: There are two kinds of input required from the Operator:

1. A **<NUMERIC KEY>** or **<FUNCTION KEY>** selection may be required to perform the desired command.

2. A DATA field entry may be required. The only way to complete a DATA field is to hit the **<ENTER>** key once the data has been satisfactorily entered, or the **<ESC>** key to CANCEL the command.

DATA DISPLAY AREAS. The data display areas are used to show important system information such as AXIS POSITION, PART PROGRAM TEXT, TOOL TABLES, etc.

NUMERIC KEYPAD COMMANDS show the available commands which can be selected with individual keys on the numeric keypad.

SPECIAL FUNCTION COMMANDS show the available commands which can be selected with individual function keys on the keyboard.

SYSTEM RUN and AUX STATUS show the state of the MDC controller. All key data registers and mode bit flags are displayed. The TOP line of the RUN STATUS display is particularly important— it shows whether the system is **OFF**, in **MAN**ual mode, in **RUN** mode or in **HOLD**. It also indicates whether input is **ABS** or **INC** and whether the system is in **B4-7** or **B8&** mode.

MDC EVENT MESSAGE. This is a 1 line event status message that displays run time dependent messages— for example fault or error messages.

Chapter 2
System Start-Up / Shutdown

The following procedure is necessary for initialization of the DX32 System. Make certain that all set up and pre-start maintenance has been completed before attempting to start the machine. Make a careful check of the following conditions before applying power.

1. Check level of lubricating oil, refill if low.
2. Check Position of X, Y, & Z axes with respect to fixtures or other parts left on the table.
3. Check Air pressure level, adjust to nominal psi.

CAUTION

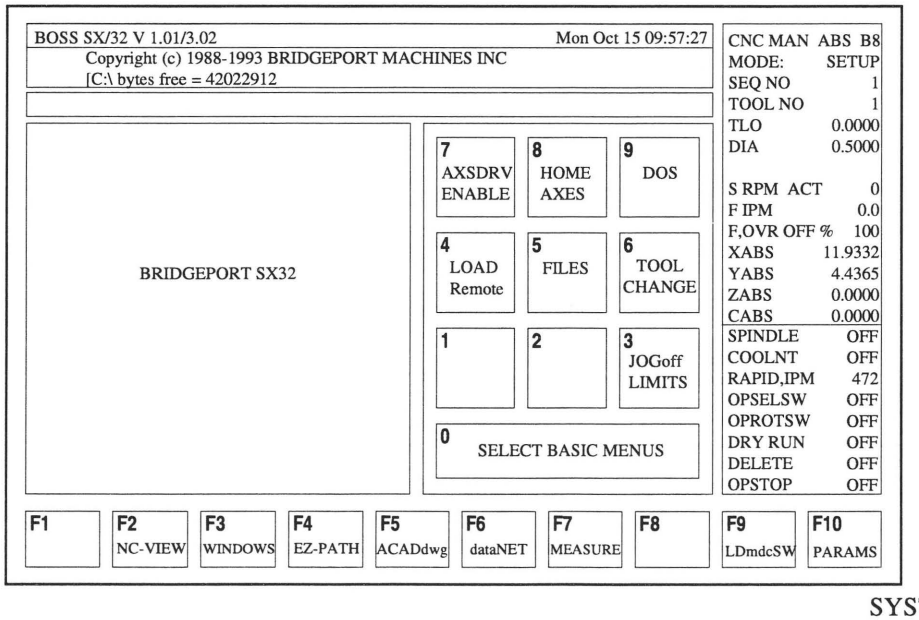
If there are problems with any of the prestart checks, do not start the machine. Check the Maintenance Manual for proper start up maintenance procedures. Failure to do so may result in machine damage.

SYSTEM POWER UP / START UP PROCEDURE

To power up the system, move the MAIN DISCONNECT switch to the ON position.

The system runs through its STARTUP diagnostics, and loads a the BMDC.BIN software from disk to the BMDC. The START-UP SYSTEM Menu appears on the screen.

NOTE: The **SYSTEM MODE** STATUS window (top line in the screen) displays the current version number of the BSX software and the date the BSX software was released. Always reference this number when calling Bridgeport for technical support.



SYSTEM STARTUP

NOTE: The **OPERATOR'S INSTRUCTION** window indicates the *bytes free* (available space) on the system disk. To save new programs on disk, it may be necessary to insert a new (previously formatted) diskette in the disk drive.

The system commands available from the **STARTUP** screen are:

[1] **SET PARAMs**. Enables entering system parameters, see also [F10].
[3] **JOGoff LIMITS**. Provides the ability to jog-off the axis limit switches. This may be necessary prior to homing if the axis position is such that a limit switch is actuated.
[4] **LOAD Remote**. Provides a communications link to remote devices.
[5] **FILES**. Provides the ability to DELETE, RENAME, COPY and APPEND DATA and TEXT files.
[6] **TOOL CHANGE**. Accesses Tool Changer settings, (308 only).
[7] **AXSDRV ENABLE**. Enables power to the axis drives.
[8] **HOME AXES**. Initiates the machine homing sequence.
[9] **DOS.** Exits to the MS-DOS operating system.
[0] **SELECT BASIC MENUS** Selects the BASIC OPERATION screen display.

The displayed **START-UP** commands which can be executed using the Function keys are:

[F2] **NC VIEW** Execute the NC-VIEW software.
[F3] **WINDOWS**. [Enhanced Performance Option] This command exits to Microsoft Windows environment.
[F4] **EZ-PATH** [Enhanced Performance Option] This command exits to DOS and calls EZ-PATH for graphics based simplified part-programming.
[F5] **ACADdwg** [Enhanced Performance Option]. This command exits to DOS and calls an ACAD drawing manager which displays a part drawing created with AutoCAD.
[F6] **DataNET** [Enhanced Performance Option and NETWORK Option]. This command links with a high-speed data network for client-server based communications.
[F7] **MEASURE**. Enables the optional PROBE routines.
[F9] **LDmdcSW**. This enables reloading the BSX*.HEX software into the BMDC.
[F10] **PARAMS**. This enables configuring system parameters.

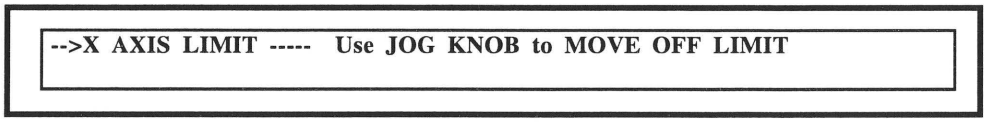
The **[ESC]** key is used to clear the **EVENT STATUS** messages.

NOTE: Pressing **[ESC]** does not correct the cause of the ERROR message. The error condition must be corrected before the machine can continue to operate.

AXIS DRIVE START UP PROCEDURE

Press **[7] AXSDRV ENABLE** to power up the drives.

If an Axis LIMIT has been exceeded, the **OPERATOR'S INSTRUCTION** window reads:



Use the JOG Knob to move the axis off the Limit.

CAUTION. To guard against damage to the machine select the correct jog direction.

Press **[8] HOME AXES** twice to initiate the machine homing sequence.

1. Quill moves up to "Home" position.
2. The X and Y axes move to the"Home" positions in sequence.

The **SYSTEM STATUS** window shows the **XABS, YABS, ZABS** position. Prior to homing **Not Homed** is displayed. If the Axes have exceeded a limit, Axis **LIMIT** is displayed. Additionally, the **EVENT STATUS** window may display an ERROR message describing a System Fault.

CONDITIONS FOLLOWING START UP

Immediately following a successful start up, the BASIC OPERATION screen is displayed. (See Chapter 3). The active tool is T1. When the quill goes "Home", Z is set equal to the T1 tool length offset. The initial (default) condition of the system is:

BOSS 8&- Operation Mode. (BOSS 8 and up)
G0 - Rapid Traverse
G30 - Mirror Image - OFF
G44 - Constant Surface Feed Control - OFF
G72 - Transformation - OFF
G90 - Absolute Programming
G17 - X, Y Plane Circular Interpolation
G40 - Diameter Compensation - OFF
G70 - Inch/Metric mode (non-volatile)
G75 - Multiquadrant Input
DNC - OFF

NORMAL SHUTDOWN PROCEDURES

Use the following procedure to shutdown overnight, or for an extended period of time.

1. Select Block mode or wait for a tool change block if a program is running.
2. Turn spindle OFF.
3. Switch machine Main Disconnect to OFF.

EMERGENCY STOP SHUTDOWN

This should be used only when safety is threatened. When activated, it disengages the spindle motor and the axes drives. Program execution is terminated.

NOTE: The part program and TLO/DIA data are not lost, but axis position is lost. It is necessary to re-home the machine after an EMERGENCY STOP.

POWER FAILURE

Loss of power to the machine for more than 1/60 of a second (1 cycle) causes a system shutdown. Use the initial system start up procedure to restart the machine after power failure.

NOTE: System RESET may be required if power was off for less than one half second.

RESET

Pressing the RESET Pushbutton Switch sets the DX32 in an initial startup condition. Follow the start up procedure.

XT SYSTEM CONFIGURATION

Press **[F10] XT SYS Config** to set various system parameters.

Use the **[UP]** and **[DOWN]** cursor keys to select the parameter to be changed.

The system parameters that can be set via the **SYS Config** screen are:

MAX RATE

Entering a value limits the rapid traverse rate.

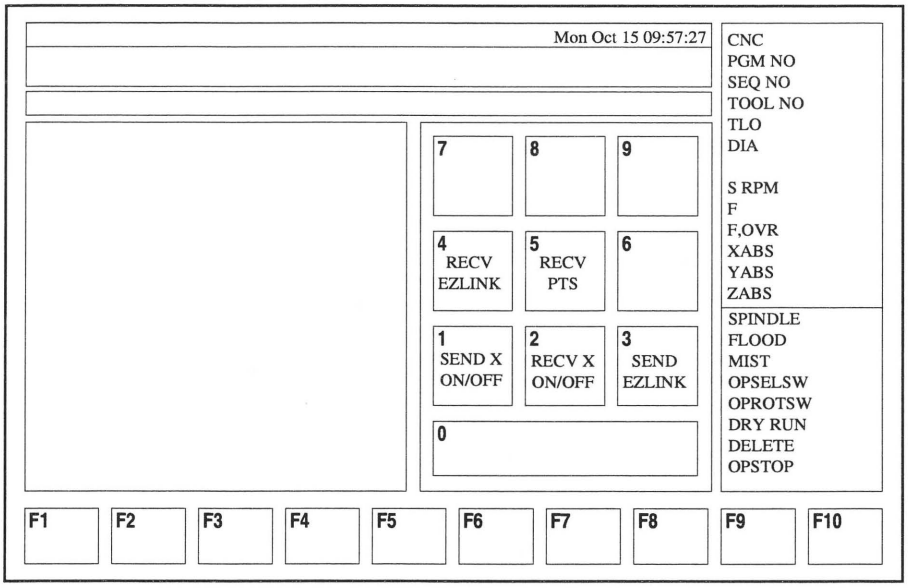
BACKLASH COMPENSATION

Entering a 2 digit number from 2-25 sets the designated backlash value into the system. If the value is less than 2, the system defaults to a backlash value of .0002.

The system configuration values are saved in a file named BMDCPRMS.SYS. *Thus, it is important that the DX32 SYSTEM DISK is matched with the machine with which it is used, otherwise, configuration values (e.g. backlash) may not be set properly.*

LOAD REMOTE

Press **[4]** to enable linking a remote device and the DX32 via the RS-232 serial communications interface. The screen displays:



LOAD REMOTE

The **LOAD REMOTE** commands available are:

[1] **SEND X ON/OFF**. XON/OFF is a no-frills protocol often used by RS-232 capable devices. SEND uploads a file from the DX32 to a remote system.

[2] **RECV X ON/OFF**. RECV downloads a file from the remote system to the DX32.

[3] **SEND EZLINK**. EZLINK is a BRIDGEPORT protocol for connecting EZ-CAM systems to CNCs. The protocol is found in Appendix A. SEND uploads a file from the DX32 to EZ-CAM.

[4] **RECV EZLINK**. RECV downloads a file from a remote system to the DX32.

[5] **RECV PTS**. This is a protocol for receiving data from the BRIDGEPORT paper tape reader emulator.

After one of the above protocols is selected the commands available are:

[F2] **EXIT**. Ends the LOAD session.

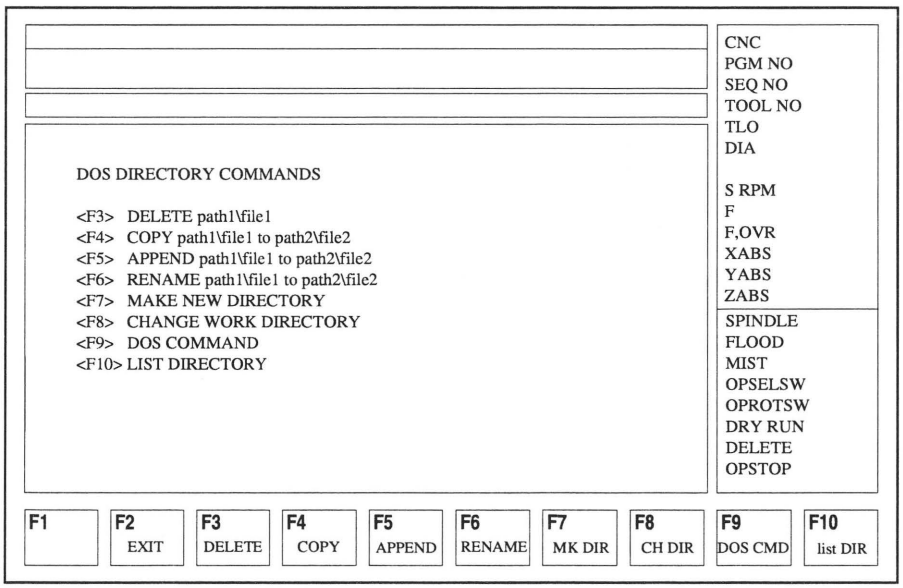
[F3] **LOAD**. Starts-up the link to the remote device. **LOAD TO REMOTE** displays the files currently stored on the disk and asks for the old filename to be loaded to the remote system. **LOAD FROM REMOTE** asks for the new filename to which data received from the remote device is stored.

[F4] **BAUD**. Enables setting the baud rate for the RS232 link. The existing baud rate is displayed as a default value.

NOTE: To use **REMOTE LOAD** the proper cable must be connected between the remote device and the DX32.

FILES

Enter **[5]** to select the **FILES** menu. The screen displays:



FILES

This menu is a user friendly DOS shell which enables use of DOS commands. A cursor-driven FILE SELECT screen is displayed so that the operator can easily enter path names and filenames. When the required information is entered, DOS is called and the desired command is executed. The commands which can be executed by using the Function Keys are:

[F2] **EXIT**. Exits the FILES menus.

[F3] **DELETE**. Deletes a FILE from the disk.

[F4] **COPY**. Makes a backup copy of the FILE on the disk.

[F5] **APPEND**. Appends a FILE to another FILE. The first file selected is appended to the second file selected.

[F6] **RENAME**. Renames a FILE.

[F7] **MK DIR**. Creates a NEW Directory

[F8] **CH DIR**. Changes the working directory.

[F9] **DOS CMD**. Enters and executes a one line DOS command

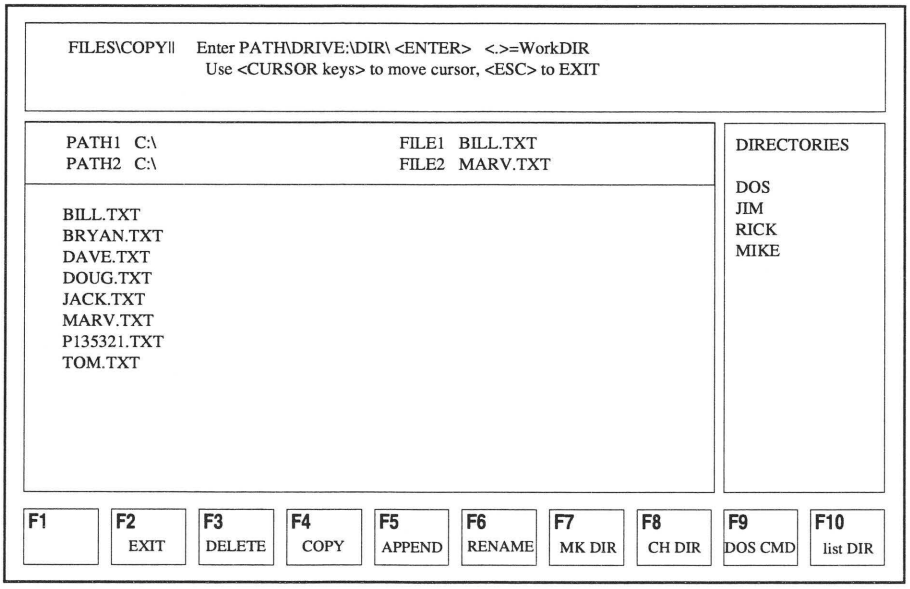
[F10] **LIST DIR**. Lists all the files in the directory.

When any of these keys are pressed the screen displays the FILES SELECT screen. This screen shows all the TXT files and the directories stored in the current working directory. The operator is prompted to enter the desired path and file names for the chosen DOS command. A blinking PATH or FILE indicates the field in which data is to be input.

NOTE: Use **[ESC]** in FILE to CANCEL an entry or in PATH to EXIT the command.

Within a PATH field, the right and left arrow cursor keys can be used to advance the cursor to any character. When the FILE name is to be input the cursor keys can be used to select a previously stored file.

NOTE: If a new PATH name is entered in the path field, the system sends the filenames with a .TXT extension. The system then repeats the new pathname. Press <ENTER> to advance the cursor to the FILE input field.



FILES SELECT

After the data for the command is filled in and <ENTER> is pressed, DOS is called and the command is executed. For a COPY command the screen displays:

DOS COMMAND: COPY C:\BILL.TXT C:MARV.TXT

If the command is successfully executed the screen displays:

DOS COMMAND: COPY C:\BILL.TXT C:MARV.TXT
1 Files(s) copied
HIT <any KEY> to EXIT DOS
Hitting any key returns the system to the FILES mode

Chapter 3
Basic Operation

The **BASIC OPERATION** mode contains the commands most frequently used by the operator. The following operations are available:

1. Axis jog, axis motion and establishment of machine/part program coordinate system
2. Entering, storing and loading Tool Data
3. Setting of RUN mode- RESET program, AUTO, BLOCK.
4. Operation of machine functions- COOLANT, FEEDRATE OVERRIDE
5. Loading part programs
6. Editing part-programs

BASIC OPERATION SCREEN DISPLAY

The Basic Operation Screen Display consists of the following information fields:

SYSTEM MODE. This is a 1 line System Mode status message. The time is also displayed.

OPERATOR INSTRUCTIONS. This is a 2 line field containing instructions for the operator.

AXIS POSITION. This shows the X, Y, Z ABSOLUTE Position in large numerals.

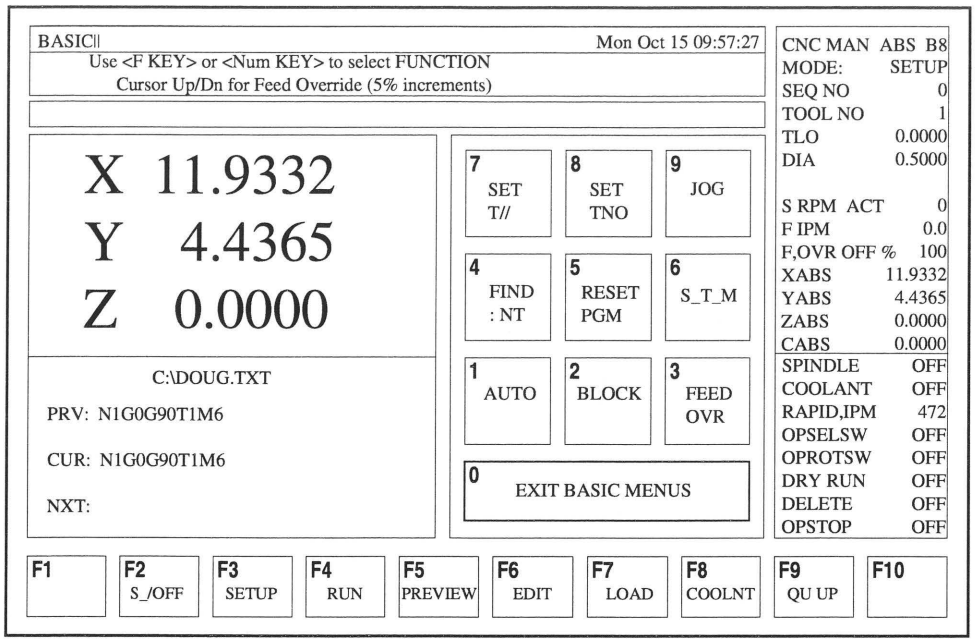
OPERATOR'S DATA. This displays the part-program. It also may show the TOOL tables for TLOs and DIAs or the setup POINT values.

NUMERIC KEYPAD COMMANDS. This shows the commands selectable with the numeric keypad.

SPECIAL FUNCTION COMMANDS. This shows the commands selectable with the special function keys.

SYSTEM STATUS. This shows the important BOSS system values. It also shows the state of auxiliary functions and RUN operating modes.

EVENT STATUS. This is a 1 line status message that is displayed when a fault message occurs.



BASIC OPERATION

The displayed **BASIC OPERATION** system commands which can be executed using the Numeric Keypad are:

[1] **AUTO**. Sets the system in **RUN/AUTO** mode. Hitting the START button begins automatic execution of the part-program.

[2] **BLOCK.** Sets the system in **RUN/BLOCK** mode. Hitting the START button begins block-by block execution of the part-program.

[3] **FEED OVR.** In **RUN MODE**, this enables use of the rotary JOG switch to override programmed feed rates.

[4] **FIND :NT**. Searches the part program for a particular :, N, or T value.

[5] **RESET PGM**. This resets the part program text pointer back to the top of the program. It also initializes the system RUN registers.

[6] **S_T_M.** Enables manual data input of S, T, and M values.

[7] **SET T//**. Enables data entry of TLO and DIA values.

[8] **SET TNO.** Enables inputting a value for the active tool number.

[9] **JOG**. Calls the JOG screen. In addition to Axis JOG and MOTION commands, the JOG screen contains a convenient set of commands for setting the machine up.

The displayed **BASIC OPERATION** system commands which can be executed using the Special Function Keys are:

[F2] S_/OFF. Shuts off the spindle.

[F3] SETUP. Enables selecting the SETUP Screen Display and Commands.

[F4] RUN. Enables selecting the RUN Screen Display and Commands.

[F5] PREVIEW. Provides a graphic display of the part program.

[F6] EDIT. Loads the screen based editor into the system.

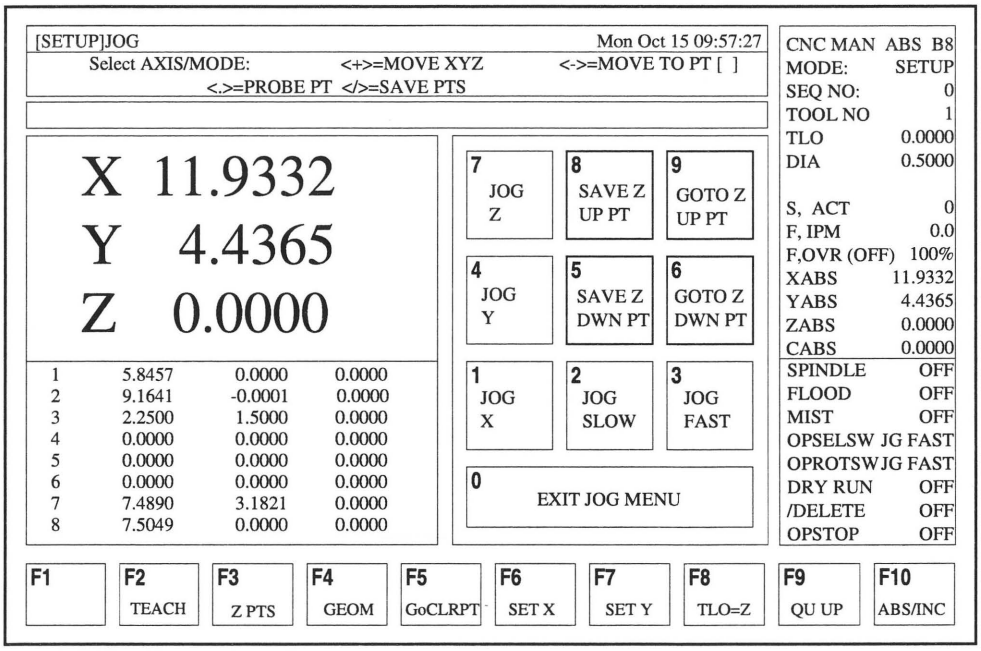
[F7] LOAD. Loads the part program text stored on disk to the CNC. It also executes a RESET PGM command.

[F8] COOLNT. Selects and turns ON and OFF Coolant FLOOD or MIST.

[F9] QUILL UP. Moves the Z Axis to the UP position.

BASIC OPERATION

After the axes drives have been enabled and the axes have been homed, the **BASIC OPERATION** mode can be used to set-up and run the DX32. Use **[9] JOG** to set-up the machine. The display reads:



JOG

The displayed **NUMERIC KEYPAD** commands available from the JOG screen are:

[1] **JOG X, [4] JOG Y, [7] JOG Z** select the jog axis of motion. A blinking number indicates which axis is being selected.

[2] **JOG SLOW, [3] JOG FAST** selects the resolution for jog motion. Jog is executed by using rotating the incremental jog knob or depressing the two position [+,-] jog switch. In **JOG**

SLOW the resolution of the incremental jog knob is .01/REV and the selected jog axis is moved .0001" each time the jog switch is depressed. In **JOG FAST** the resolution of the incremental jog knob is .1/REV and continuous motion occurs when the jog switch is depressed.

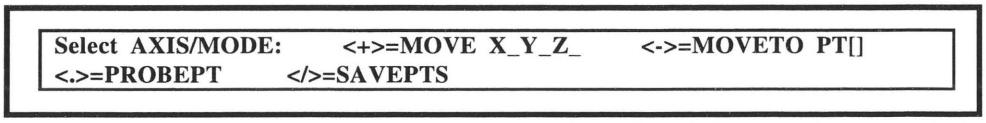
When F3 Z PTS is selected, the following will appear:

[5] **SAVE Z DWN PT**, **[8] SAVE Z UP PT** store the current position of the Z Axis in system memory. The saved value is displayed in the **SYSTEM RUN STATUS** display as **Z UP** and **Z DWN**.

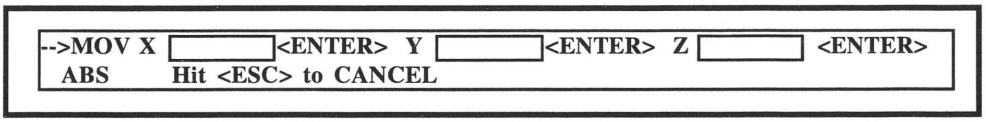
[6] **GOTO Z DWN PT**, **[9] GOTO Z UP PT** move the Z axis to the previously stored points. Use **<+>** to move the axis.

JOG AXIS MODES

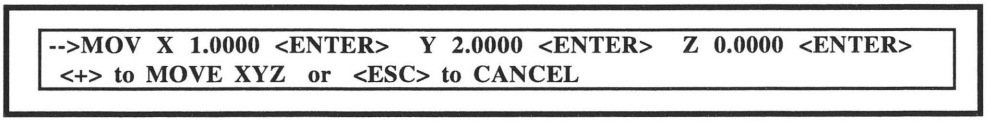
The **OPERATOR INSTRUCTION** window for the basic **JOG** screen displays:



If <+> is pressed the **OPERATOR INSTRUCTION** window displays:



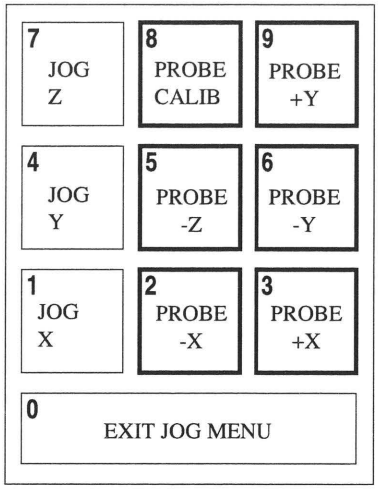
The X, Y default values are the values for the last saved point. ABS indicates the input mode. Press <ENTER> without a value to advance the input pointer past a field. After the X, Y, Z move values are entered the **OPERATOR INSTRUCTION** window displays:



Pressing <+> moves the axes to the desired position.

The commands called by the Numeric Keys **[5], [6], [8]** and **[9]** depend on the **JOG AXIS** mode. The **JOG AXIS** mode can be altered by using the **<.>** key, **F4 GEOM** and **F3 Z PTS**.

<.> selects the **PROBEPT** mode [PROBE Option]. This mode is used with a Renishaw probe to touch off points on the part surface. When **<.>** is selected the numeric key pad display reads:



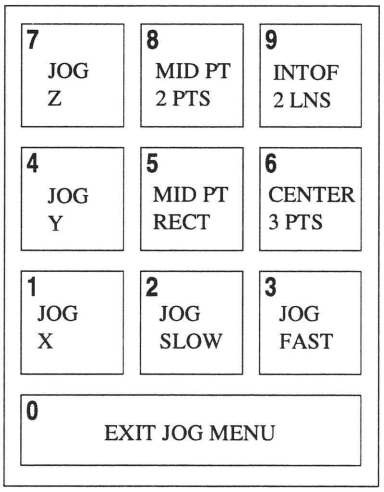
Use **[2] PROBE -X, [3] PROBE +X, [5] PROBE -Z, [6] PROBE -Y**, or **[9] PROBE +Y** to move the probe into the part. After the probe hits the part it automatically saves the touch point, and backs off from the part. The **OPERATOR INSTRUCTION** window displays:

```
--> SAVE XY PT [1 thru 8]: ❑ <ENTER>          <ESC=CANCEL
      @X1.0000   Y 2.0000
```

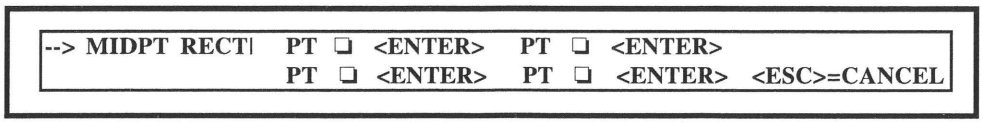
Entering a value from 1 through 8 stores the saved probe touch point in the stored POINT table.

NOTE: The probe keys are situated so as to help the operator determine the direction of the probe motion.

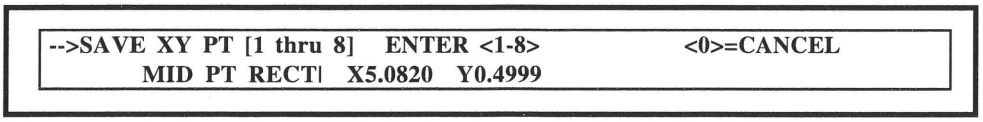
[F4] selects the **GEOMETRY** mode. This mode is used together with the stored POINT table to construct the midpoint of a line, the midpoint of a parallelogram or the center of a circle. When **F4** is selected the numeric keypad displays:



[5] **MID PT RECT**. Calculates the mid point of a rectangle by finding the midpoint of a line defined by the first two points entered and the midpoint of a line defined by the second two points entered. The **OPERATOR INSTRUCTION** window displays:

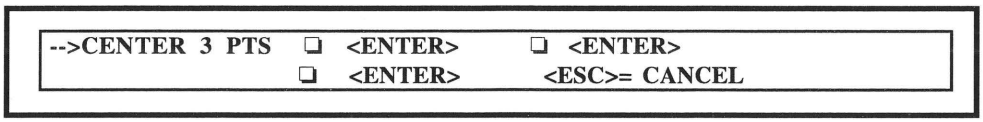


For each of the four points, enter the number from 1 through 8 identifying the desired previously stored point. After four points have been entered, the **OPERATOR INSTRUCTION** window displays:

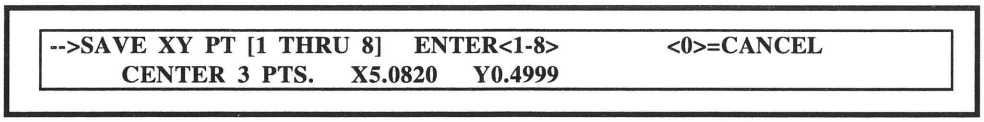


Entering a value from 1 through 8 stores the coordinates of the calculated midpoint in the saved **POINT** table.

[6] **CENTER 3 PTS**. Calculates the center of a circle from three points lying on the circumference of the circle. The **OPERATOR INSTRUCTION** window displays:

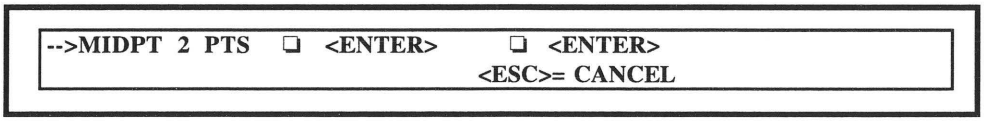


For each of the three points enter the number 1 through 8 identifying the desired previously stored point. After the data is entered the **OPERATOR INSTRUCTION** window displays:

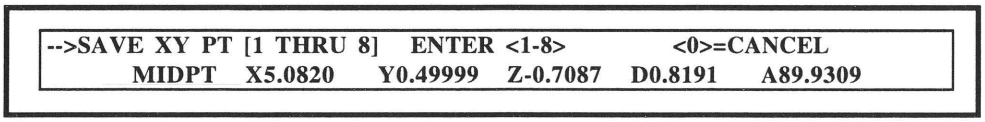


Entering a value from 1 through 8 stores the coordinates of the calculated center point in the saved **POINT** table.

[8] **MID PT 2 PTS.** Calculates the mid point between two points, and also provides information about the 2 points. The **OPERATOR INSTRUCTION** window displays:



For each of the two points enter the number from 1 through 8 identifying the desired previously stored point. After two points have been entered the **OPERATOR INSTRUCTION** window displays:



D is the distance between the points, and **A** is the angle the 2 points make with the +X axis.

Entering a value from 1 through 8 stores the coordinates of the calculated center point in the saved **POINT** table.

[9] **INTOF 2 LNS.** Calculates the intersection of two lines. Each line is determined by two points along the line. The **OPERATOR INSTRUCTION** window displays:

```
-->INTOF 2 LNS     LN1 PT. ❑ <ENTER>     PT. ❑ <ENTER>
          LN2 PT. ❑ <ENTER>     PT. ❑ <ENTER>      <ESC>=CANCEL
```

For each of the two lines enter the number from 1 through 8 identifying the desired previously stored points. After four points are entered the **OPERATOR INSTRUCTION** window reads:

```
-->  SAVE XY PT [1 thru 8]    ENTER<1-8>              <0>=CANCEL
       X2LN1  X7.2945   Y-5.3249   Z-0.7087   A89.9301   A-4.6637
```

Hit any KEY to CONTINUE operation.

SPECIAL FUNCTIONS

The displayed **SPECIAL FUNCTION** commands available from the JOG screen are:

</> **SAVE PTS.** Stores the value of the current X, Y position in the saved POINT table. Once saved the point can be recalled and used later in the set-up process. The **OPERATOR INSTRUCTION** window displays:

```
-->SAVE XY PT [1 thru 8] ❑ <ENTER>          <ESC>=CANCEL
   @ X 1.0000   Y 2.0000
```

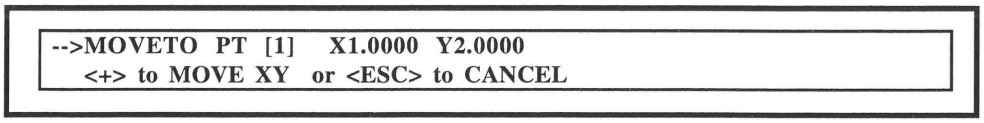
Entering a value from 1 through 8 stores the coordinates of the point in the saved POINT table.

If **<->** is pressed the axes can be moved to a previously saved point in the point table. The **OPERATOR INSTRUCTION** window displays:

```
-->GOTO  XY PT [1 thru 8]   <HIT 1-8> or <ESC> to CANCEL
   <->=GOTO XYZ PT.
```

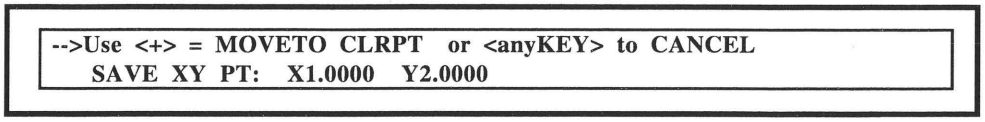
If the **<->** key is pressed, the axes will move to the XYZ saved point.

After the desired saved point has been entered the **OPERATOR INSTRUCTION** window displays:



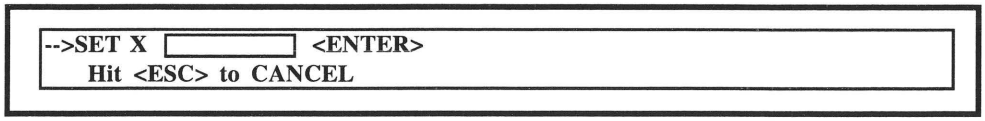
Hitting the <+> Key moves the table to the previously saved position.

[F5] **GOTO CLR PT**. This moves the table to the clear point position. The point from which the move is made is temporarily stored and is automatically entered as default X and Y values when a **MOVETO XYZ PT** command is selected. The **OPERATOR INSTRUCTION** window displays:



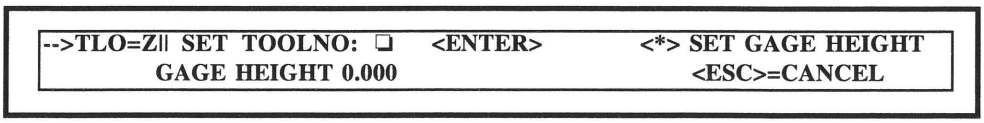
Hitting the <+> Key moves the table to the clear point

[F6] **SET X, [F7] SET Y**. Enables setting a part-program coordinate value to the current position. The **OPERATOR INSTRUCTION** window displays:



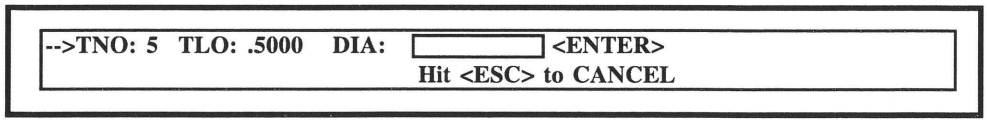
Entering a value sets the current position to the X part-program coordinate value entered.

[F8] **TLO=Z**. Sets the **TLO** for the designated tool equal to the current Z coordinate value and provides the ability to enter a cutter diameter. The **OPERATOR INSTRUCTION** window displays:



<*> SET GAGE HEIGHT gives the operator the ability to set tools with a gage block of known thickness. By entering * at the **TOOLNO:** prompt, the control then allows the operator to enter the thickness of that gage block. The control will then automatically calculate the proper TLO in relation to the part surface.

After a tool number is entered the **OPERATOR INSTRUCTION** window displays:



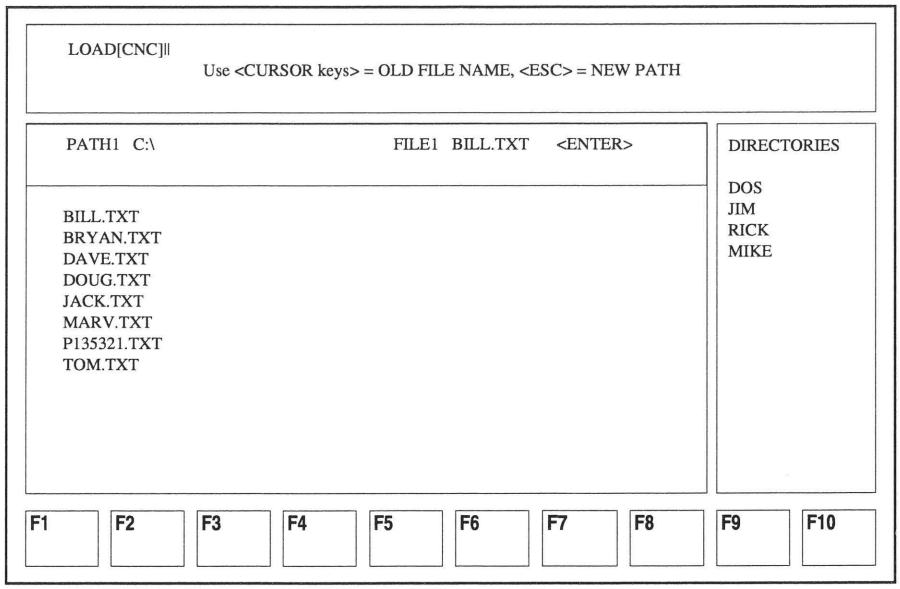
Entering a value sets the DIAMETER saved for that tool number in the stored TOOL table.

[F9] **QUILL UP** Moves the quill to the up position

[F10] **ABS/INCR** Toggles the system between the Absolute or Incremental input modes.

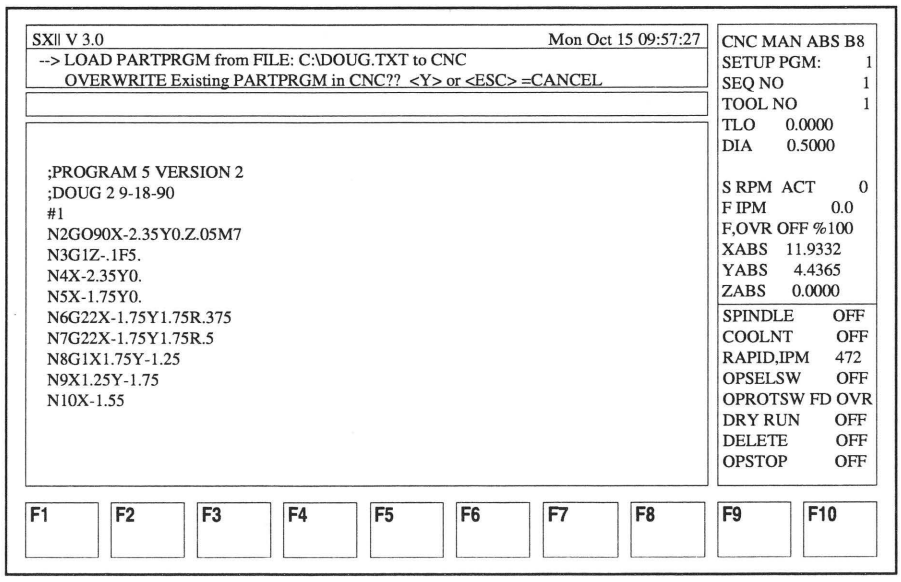
In the main BASIC screen, hit **<0>** to **EXIT** the JOG menu.

After the part is set-up, use **[F7]** to **LOAD** the part-program from disk to the CNC. The display reads:



LOAD FILENAME

Select the PATH and FILENAME to be loaded to the CNC. The display reads:



LOAD PARTPROGRAM

Hitting **<Y>** downloads the part-program to the CNC.

Press **[5]** to RESET the program and to set the system in **AUTO**.

To turn the spindle **ON** under manual control, hit **[6] S_T_M_** and input the desired data.

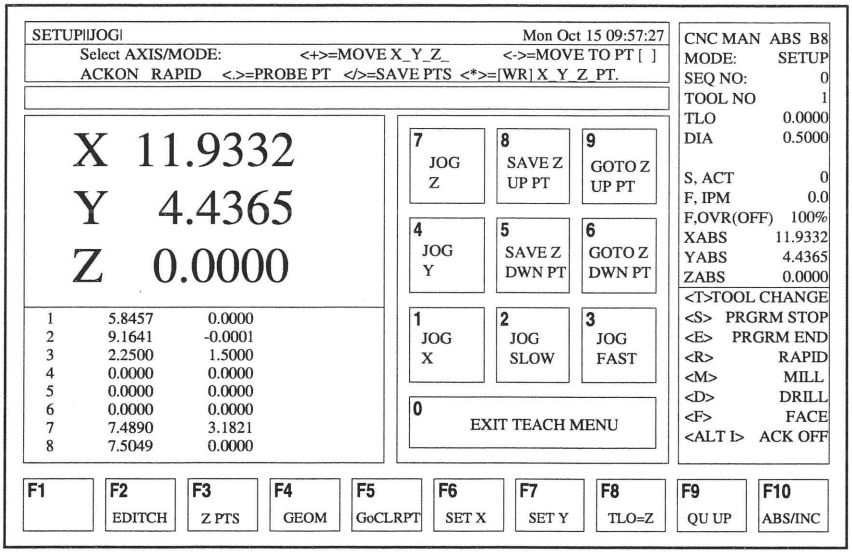
Hitting the **START** push-button starts execution of the program at the current location of the part-program text pointer. Use **[F8]** to turn the **COOLANT ON** and **[3]** to enable **FEEDRATE OVERRIDE** if desired. Use the RPM jog selector switch to increase/decrease the spindle speed by 3% each time the button is depressed.

TEACH MODE

Pressing the **F2 TEACH** key in the **JOG** mode sets the system into the **TEACH** mode. In this mode the JOG commands can be used to move the axes after which teach commands are available to write the current coordinate values into a file called **TEACH.TXT**.

WARNING: Entering the **TEACH** mode overwrites the previous contents of the file **TEACH.TXT**.

The **TEACH** mode display reads:



TEACH MODE

On entering the **TEACH** mode, N0G0G90 is written as the first block of code in the file **TEACH.TXT**.

The **TEACH** mode commands available are:

[*] Enters the current coordinate value as a block of text in **TEACH.TXT**. If **ACK** is **ON**, the **<ENTER>** key needs to be pressed to enter the data. If **ACK** is **OFF** (use **<ALT I>** to toggle **ACK OFF/ON**) the data is entered as soon as the * is depressed.

[O] Ends the program. NG0M22 is written and the **TEACH** mode is terminated.

[T] Enables a T value. A NG0T1M26 block is written.

[S] Enables a **PROGRAM STOP**. A NG0M20 is written.

[E] Ends the Teach program.

[R] Enables the **RAPID** mode. The current coordinates are prefixed with a G0 code. For example, NG0X12.Y7.Z10.

[M] Enables the **MILL** mode. A prompt asks for the feedrate to be entered. The current coordinates are prefixed with a G1 code. The F code will appear at the end of the block.

[D] Enables the **DRILL** mode. A prompt asks for Z depth and feedrate. The current coordinates will be prefixed with a G81 code. The Z depth and feedrate will appear at the end of the block, i.e. G81X1.Y1.Z.5F10.

[F] Enables a quick simplified **FACE** routine. The axes are assumed to be at the extreme left and bottom of the surface to be faced, and the current depth is assumed as the facing depth. A prompt asks for **X**, total X distance; **Y**, total Y distance;**Y**, step Y distance and **F**, Feed. A macro routine to face the surface is automatically generated.

[F3] EDI TCH Sets the system in the **EDIT** mode for modifying **TEACH.TXT**. On exiting from the editor the system returns to the **TEACH** mode.

Chapter 4
Set Up

The **SET UP** mode is used to prepare for execution of a part program. The following operations are available:

1. Establishment of machine/part program coordinate system
2. Axis motion to set-up positions
3. Axis jog
4. Entering, storing and loading Tool Data
5. Loading part programs
6. Editing part-programs

SET-UP SCREEN DISPLAY

The **SET-UP** Screen Display consists of the following windows:

SYSTEM MODE. This is a 1 line System Mode status message.

OPERATOR INSTRUCTIONS. This is a 2 line field showing instructions for the operator.

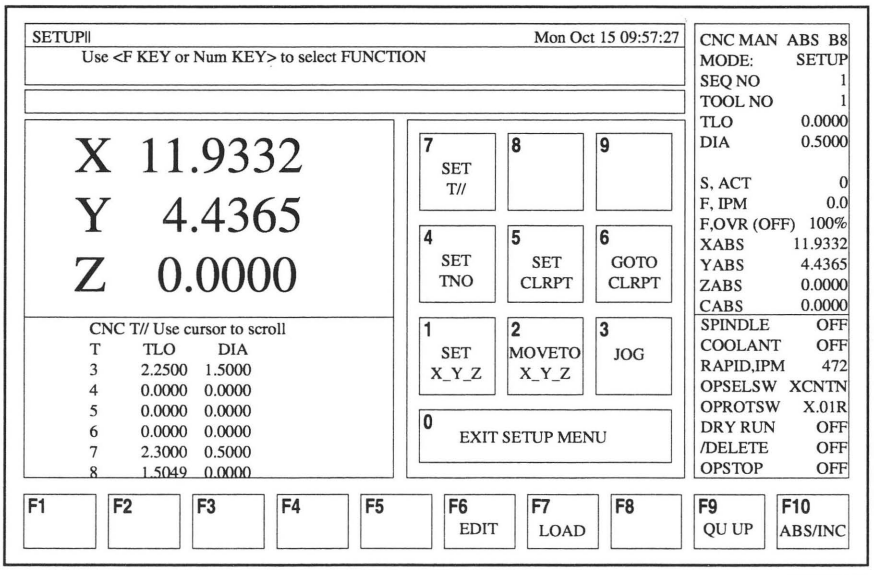
AXIS POSITION. This shows the X, Y, Z ABSOLUTE Position in large font.

TOOL DATA. This displays the TLO and DIA Compensation values for 24 Tools.

NUMERIC KEYPAD COMMANDS. This shows the commands selectable with the numeric keypad.

SPECIAL FUNCTION COMMANDS. This shows the commands selectable with the special function keys.

EVENT STATUS. This is a 1 line event status message that typically is displayed when a fault message occurs.



SETUP COMMANDS

The displayed **SETUP** system commands which can be executed by using the Numeric Keypad are:

[1] **SET X_Y_Z_**. Assigns coordinate values to the current position of axis motion.

[2] **MOVETO X_Y_Z_**. Moves the X, Y, Z to the entered position.

[3] **JOG**. Enables Jogging the Axes. The JOG Screen is called up, which, in addition to Jog commands, also includes a convenient set of commands for setting up the machine.

[4] **SET TNO**. Enables inputting a value for the ACTIVE tool number. This causes the TLO and DIA compensation values associated with the tool number to become the values active in the execution of the part program. This function is only active on machines without a tool changer.

[5] **SET CLRPT**. Enables setting the X, Y, position as the Clearance Point to be used to facilitate tool changes.

[6] **GO CLRPT**. Moves the axes to the Clearance Point.

[7] **SET T//**. This enables Data Entry of TLO and DIA values. NOTE: This command does not set the Active Tool Number. It updates the values stored in the tool table.

[0] **EXIT SETUP MENU**. This returns back to the BASIC Screen Display and Commands.

The displayed **SETUP** system commands which can be executed by using the Special Function Keys are:

[F6] **EDIT** Loads a screen based editor into the system.
[F7] **DSKCNC** Loads partprogram data stored on disk to the CNC.
[F9] **QU UP.** This moves the Z-Axis to the Home position.
[F10] **ABS/INC** Sets the system in Absolute or Incremental Position Mode.

DX32 COORDINATE SYSTEMS

MACHINE COORDINATE SYSTEM

The Machine Coordinate System is referenced off the mechanical axis limit switches and the homing marker on the axis motor encoders. When the axes are homed, the X, Y, and Z system registers that track axes motion are set to zero. The Operating System handles all motion commands in the Machine Coordinate System. This is to ensure that all moves are within the axis limits.

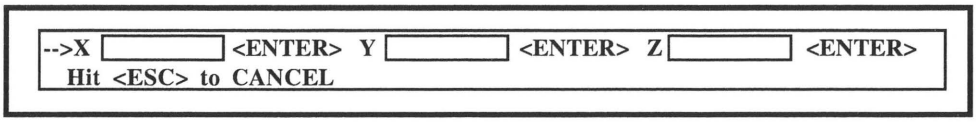
PART-PROGRAM COORDINATE SYSTEM

The user can set the location of the Part-Program Coordinate System with respect to the Machine Coordinate System. This is done by using the **SET X_Y_Z_** command. All user motion commands including **MOVE X_Y_Z_** and Part-Program Motion Data are entered with respect to the Part-Program Coordinate System. Internally the Operating System converts the Part-Program coordinate values back to Machine coordinates.

Setting the Part-Program Coordinate System

SET X_Y_Z_ enables the operator to orient the Part-Program Coordinate System with respect to the Machine Coordinate System. To do this, the operator enters the values to be set as the Part-Program Coordinates for the current machine travel position. For example, if the Axes were homed and Part-Program 0,0 was 8.0 away on X, and 5.0 away on Y, the operator enters **[1] SET X_Y_Z_**. The **OPERATOR INSTRUCTION** window

displays:



The Operator then enters X 8.0, Y 5.0. Do not enter a value for Z.

Once this command is selected, all the fields of data prompted for on the screen must be entered before the command can be exited. To CANCEL the command, hit the **ESC** key with the X, Y, and Z values set to NULL. To position the cursor to a field that was previously written to, use the **UP ARROW** and **DOWN ARROW** cursor position keys.

NOTE: To set Z zero position anywhere other than at the home position, a tool with a TOL of 0.0 should be active.

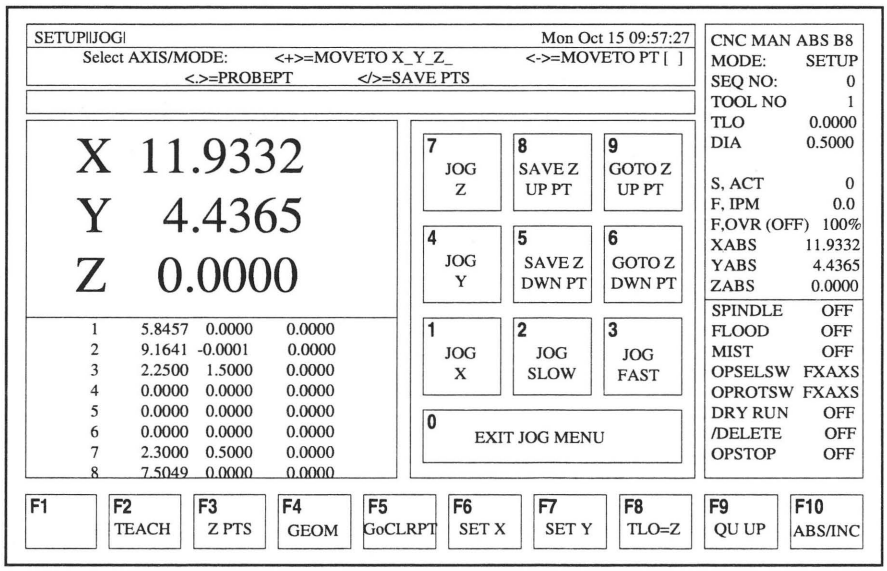
Setting Up the Tool Change Clearance Point

TOOL CHANGE CLEARANCE POINT

The Clearance Point can be used during the tool change operation. This is an arbitrary point, established by the operator, which allows adequate clearance for the tool change. Use **[F9] QUILL UP** to move the Z axis to the Home position. JOG the X and Y axes to any convenient point away from the work piece where operations such as Program Stop or Tool Change can take place. Then enter **[5] SET CLRPT**. Entering **<1>** sets the current position as the Clearance point.

JOGGING THE AXES

Enter **[3] JOG** to view the commands available for jogging the axes. The display reads:



JOG

See CHAPTER 3 BASIC OPERATION| JOG for a description of the JOG commands.

Entering TOOL Table Data

Specific tool lengths and diameters can be entered for the tools selected to machine a part. The following tool data information can be stored.

1. Tool Length Offset (**TLO**) values
2. Tool Diameter (**DIA**) values

The data stored in the DX32 BMDC tool buffers is non-volatile, and is retained in memory with power off.

NOTES:

1. All TOOL DATA entered into the PC AT is immediately transferred to the BMDC.

2. TOOL DATA from the BMDC is automatically entered into the PC AT on system start-up the first time the SET-UP menu is accessed.

3. Because T values can be imbedded in the part-program, the actual T value used by the BMDC may not be the same as the T value displayed in the TOOL DATA window.

Enter **[7] SET T//** to call up the TOOL Table screen which enables entry of TLO and DIA values. The OPERATOR INSTRUCTION WINDOW displays:

```
-->TNO [1 thru 24]:  □<ENTER>              Hit <ESC> to EXIT
 <-> CLR ALL T//      <R> Read T// from DISK     <W> Write T// to DISK
```

Key in the tool number associated with the data to be entered. The following functions can be accessed with special (non-numeric) characters entered into the TNO field:

NOTE: The **<Enter>** key must be hit after the desired special character is used.

<-> Clears all the T// values to 0.

<R> Reads a previously stored TOOL DATA table from Disk. For both Read and Write T// the Operator's Instruction window prompts for the name of the File to be read and a window containing the names of all the TOOL DATA tables previously saved is displayed.

<W> Saves the current TOOL DATA table by writing them to Disk.

<Esc> Exits the **SET T//** screen.

TOOL LENGTH OFFSETS

Tool Length Offsets can either be entered Manually in the SETUP mode by the procedures described below or by commands embedded in the part program.

NOTE: The TOOL Tables retain the last value entered Manually, but the part program can set TLOs only if the previous value of the TLO stored in the TOOL Table is NULL.

The TOOL DATA window displays 5 sets of values starting at the current Tool number. To display a specific tool number from the 24 stored in the TOOL Table, use the SET T// command. To scroll the TOOL Table use

the UP or DOWN CURSOR CONTROL ARROW.

Setting TLOs that have not been pre-measured

When the TLO value for a particular tool has not been pre-measured, it is possible to use the machine coordinate system to determine the offset. The current Z ABS value can be entered into the TOOL table by entering a **<*>** as the TLO value in the **SET T//** menu. However the most convenient method of doing this is by using **[F8] TLO=Z** in the **JOG** menu.

Enter **[3] JOG**. Insert the longest tool into the machine and clamp the work piece to the table in the desired location. Using one of the **JOG** modes move the Z axis so that the tip of the tool just touches the "Z" zero position, usually the top of the work piece. Enter **[F8] TLO=Z**. The OPERATOR'S INSTRUCTION window prompts for the TOOLNO. Key in the desired Tool number and then hit **<Enter>**. The Z ABS value is entered into the TOOL table.

Use **[F9] QU UP** to move the Z axis to the clear point and insert the next tool in the machine. Repeat the process just described. Continue until all TLO values have been determined for each tool programmed.

Setting TLOs for pre-measured tools

The SET T// command can be used to input TLO data when tool lengths have been pre-measured. Enter **[7] SET T//.** The **OPERATOR INSTRUCTION** window displays:

```
-->TNO [1 thru 24]: □<ENTER>              Hit <ESC> to EXIT
 <-> CLR ALL T//     <R> Read T// from DISK    <W> Write T// to DISK
```

Key in the Tool Number of the TLO to be input and hit ENTER. (Or enter **<->** to CLEAR ALL T// values, **<R>**, **<W>** to read or write T// data to or from disk or **<Esc>** to exit the SET T// command.)

The **SET TLOs** message is displayed in the **OPERATOR INSTRUCTION** window.

```
-->TNO:01 TLO: [        ] <ENTER>   DIA: [        ] <ENTER>
   Enter TLO: <*> to SET TLO=ZABS              Hit <ESC> to CANCEL
```

The values for the current TLO and DIA are displayed in their respective fields. To retain the current value hit ENTER without keying in any data into the field.

The TOOL DATA window displays the 5 successive T// values starting from the Tool Number that was just entered.

NOTE: *Any modification of tool data values made in PC AT RAM automatically updates the values stored in BMDC RAM.*

CUTTER DIAMETER COMPENSATION

Differences in tool diameter are due to wear during use and to losses during re-grinding. When a tool diameter is less than the one called for in the part program, the operator must compensate for that difference. The DX32

Operating System provides the ability to automatically calculate a new Tool Path, based on alterations between the Cutter Diameter originally programmed for and the actual tool diameter. This compensation value is entered into the TOOL Table .

Calculation of compensation value

The compensation value entered is the difference between the programmed diameter and the actual diameter.

Example:
Programmed Cutter = .500" Dia. End Mill
Actual Cutter = .485" Dia. End Mill

Compensation entered is : -.015"

If the actual cutter is smaller than that programmed, the input value is always negative. If a larger cutter than that programmed was used, the compensation value is always positive.

Setting Cutter Diameter Compensation

The **SET T//** command can be used to input DIA compensation data when the values are known. Enter **[7] SET T//** and follow the procedure described for entering TLO Data .

Moving to Position by Entering X, Y, Z Data

Use the **[2] MOVETO X_Y_Z_** command when you want to move the axes to a particular position. The X_Y_Z_ data can either be absolute or incremental. To switch from the Absolute Mode to the Incremental Mode use the **[F10] ABS/INC** command.

Moving to Fixture Reference Point, or Tool Clearance Point.

Enter **[5] GOTO CLRPT**. The display reads:

```
—>Use <+>=MOVETO CLR PT, <ESC>=CANCEL
```

NOTE: When moving to Clearance Point the Z axis moves Home before XY motion takes place.

FILING AND LOADING PART PROGRAMS

Partprograms in the DX32 can be located in three separate locations:

DISK. Partprograms are stored by name on disk. Disks can store up to 1.44 Mbytes of data. Partprogram File names stored on disk have the extension **.TXT**.

PC AT RAM. When EDIT is used a partprogram is read off the disk and loaded into PC AT RAM. At the conclusion of the EDIT session the modified partprogram can be filed on disk.

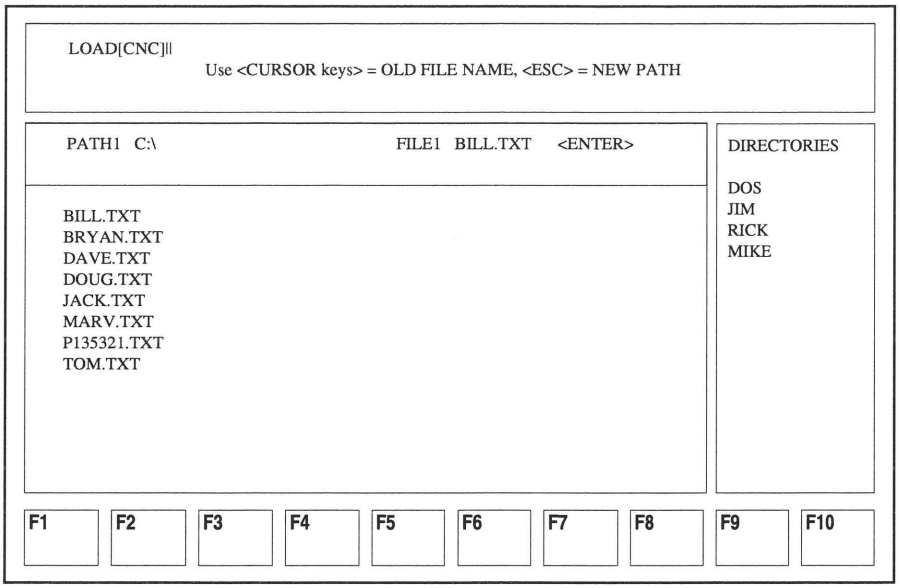
BMDC RAM. The partprogram can be loaded from disk into BMDC RAM. This is the partprogram executed

by the DX32 in the RUN mode.

NOTE: *A Partprogram with the same name may be simultaneously running from BMDC RAM and being EDITed from PC AT RAM. The changes made in the EDIT mode are not used to cut a part until the revised partprogram is loaded into BMDC RAM.*

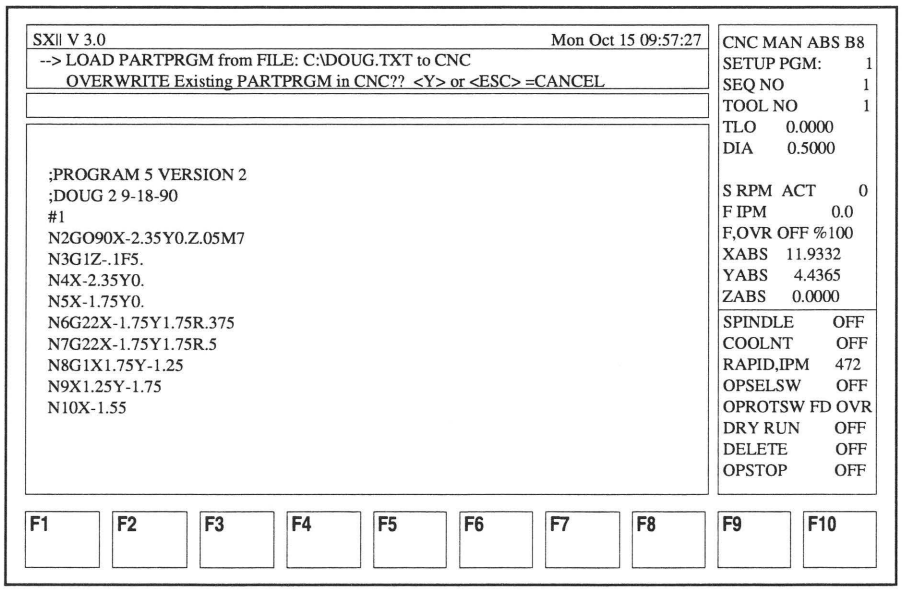
Loading a Partprogram from a File on Disk to the CNC

Press [**F7**] **LOAD** to load a partprogram to the CNC. The display reads:



SETUP: LOAD PARTPROGRAM Filename

Select the **PATH** and **FILENAME** to be loaded to the CNC. The display reads:



SETUP: LOAD PARTPROGRAM File to be loaded

The display shows the first 16 lines of the file read from the disk. The **OPERATOR'S INSTRUCTION** window displays the message *OVERWRITE Existing PARTPGM in CNC??* This message is displayed to remind the operator that loading a partprogram into the CNC overwrites the partprogram previously loaded. Enter **<Y>** to continue. A WAIT message is displayed on the screen indicating the file is being loaded from the disk to the CNC.

Chapter 5
Run

The RUN mode is used to execute the part program. The following operations are available:

1. Setting of RUN options such as /DELETE, OPSTOP, BREAKPOINT, BOSS VERSION.
2. Setting of DRY RUN modes - NO Z, MAX FEED.
3. Operation of Machine functions such as COOLANT MIST/FLOOD.
4. Optimization of the partprogram values for FEEDRATE.
5. Start-up of the program at a particular N, T or : value.
6. CLEARing out of System Registers, BMDC Part program RAM.
7. Manual Data Input of Partprograms.
8. DNC RUN of Partprograms larger than 256K.

RUN SCREEN DISPLAY

The RUN Screen Display consists of the following windows:

SYSTEM MODE. This is a 1 line System Mode status message. The Time is also displayed.

OPERATOR INSTRUCTIONS. This is a 2 line field containing instructions for the operator.

RUN STATUS. This shows the X, Y, Z axes part-program coordinates.

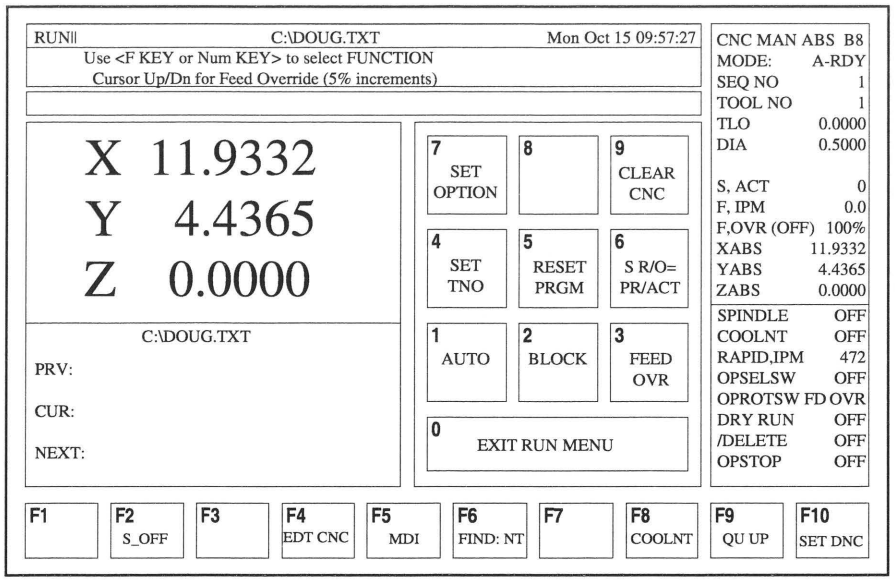
PROGRAM STATUS. This shows the previous, current, and next line of the program in execution.

NUMERIC KEYPAD COMMANDS. This shows the commands selectable by hitting the numeric keypad.

SPECIAL FUNCTION COMMANDS. This shows the commands selectable by hitting the special function keys.

SYSTEM STATUS. This shows the important BOSS system values. It also shows the state of auxiliary functions and RUN operating modes.

EVENT STATUS. When a fault condition occurs, this is a 1 line event status message.



RUN COMMANDS

The displayed **RUN** system commands which can be executed by using the Numeric Keypad are:

[1] **AUTO** Enables automatic execution of the part-program.

[2] **BLOCK**. Enables block by block execution of the part program.

[3] **FEED OVR**. Enables using the **FEED OVR** knob to override feed rates embedded in the part program.

[4] **SET TNO**. Enables inputting a value for Tool number. This causes the **TLO** and **DIA** comp values associated with the Tool number to become the values active in the execution of the part-program.

[5] **RESET PROGRAM**. This command sets the part program text pointer back to the beginning of the program. It also initializes system **RUN** registers.

[6] **S R/O= PR/ACT**. Toggles the **S,RPM** display between ACTUAL and PROGRAMMED values.

[7] **SET OPTION**. Displays the **RUN OPTION** Screen.

The commands available from the **RUN OPTION** Screen are:

[0] **EXIT OPTIONS MENU**. Returns to the **RUN** Screen.

[1] **NO Z**. Runs the partprogram with **NO Z** axis motion.

[3] **MAX FD**. Runs the program and overrides all programmed feed rates. Set the feed rate to the maximum permitted value.

[4] **OPSTOP**. When OPSTOP is ON, the partprogram stops execution at the end of a block containing a M01 command.

[5] **/DEL**. When / DEL is ON any partprogram block with a / as the first character on the block is ignored.

[6] **SET BRK PT**. Enables entering a Sequence Number. When the partprogram is run, execution stops when the BREAK POINT Sequence Number is read.

[7] **METRIC**. Sets METRIC/INCH Input Mode.

[8] **BOSS VERS**. Selects either the BOSS Version 4-7 or BOSS Version 8 & Up Mode.

[0] **EXIT RUN MENU**. Returns to the BASIC Screen Display and Commands.

The displayed **RUN** system commands which can be executed by using the Special Function Keys are:

[F2] S/OFF. Turns the spindle OFF.

[F4] EDT CNC. Displays on screen the last part-program loaded from the PC AT to the BMDC. This text can be edited and then re-loaded down to the BMDC.

[F5] MDI. Enables Manual Input, Block by Block execution and Editing of a part-program.

[F6] FND :NT. Enables searching the part program text for a particular :, N or T value.

[F8] COOLNT. Selects and turns ON and OFF coolant MIST or FLOOD.

[F9] QU UP. Drives the Z axis to the HOME position.

[F10] SET DNC. Enables running part-programs of longer than 256K characters.

NORMAL OPERATION

The **RUN** mode assumes that the part program to be run exists in **BMDC RAM** or that the **DNC LINK** has been established. If the desired program has not been loaded into **BMDC RAM** do so using the commands described in **Loading and Filing Part Programs**.

Before the part program is executed for the first time or after the system mode has been changed the **RESET PROGRAM** command must be used to initialize the control registers and set the part program text pointer to the beginning of the text buffer.

NOTE: The Filename is automatically inserted as the first line of BMDC text. Reading the Filename back from the non-volatile BMDC text buffer when the system is first started up enables the PC AT to know what the name of the last file loaded to the BMDC was even if power has been turned off.

If the operator does not want to run the partprogram from the top of the text buffer, **[F6] FND :NT** may be used to set the part program text buffer to the beginning of a data block with a particular Part Number, Sequence Number or Tool Number.

After either **RESET PROGRAM** or **FIND** has been used to position the partprogram text pointer, the next step is selecting either **AUTO** or **BLOCK** program run using either **[1] AUTO** (continuous operation of the part program) or **[2] BLOCK** (block by block) RUN modes.

When using **BLOCK** mode, the **START** switch must be pressed to reactivate the program after each executed block.

If AUTO is in effect and BLOCK is activated, the control finishes the current block, and then stops. Non-motion blocks such as G91, G90, G71, G70, G4 (Dwell), G96, G97, etc., on lines by themselves change status and update axis registers

but the program does not halt at the end of non-motion blocks.

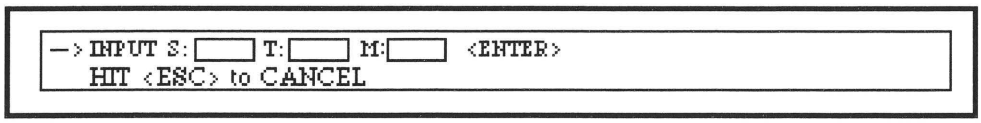
For example:

In Block Mode
N50 G0X3.Y2. Machine stops execution at the end of the Rapid move.
N55 G91 Machine changes mode to incremental and execute next block.
N60 G1X2.Y2.F10. Machine stops execution at the end of the feed move.

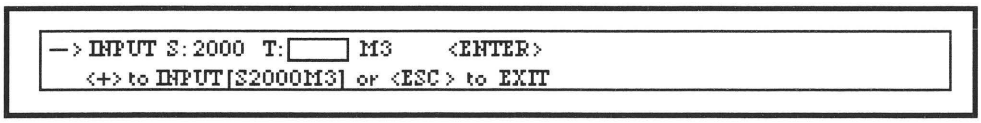
NOTE: A loop call or a macro call is considered a motion block. A macro subroutine definition is non-motion.

Starting The Spindle

It is assumed the spindle is completely under part-program control using M3, M4 and M5 commands. To start the spindle up manually, go to the BASIC screen and use [6] S_T_M. The **OPERATOR INSTRUCTION** window displays:



Enter the Speed in the S field and M3 or M4 for CW, CCW rotation in the M field.
The **OPERATOR INSTRUCTION** window displays:



Hitting the <+> key causes the spindle to rotate at 2000RPM

Program Run

The first time through the part program in AUTO or BLOCK , **[5] RESET PROGRAM** must be used to initialize the various control registers. This sets the part program text pointer to the first executable block. The first block of a part program could be:

N1G0G90T1M6

This block of code sets the system in absolute positioning mode and causes the T1 tool parameters to become active. The M6, tool change, causes the Z axis to move to tool change position and insert the tool called.

NOTE: If the operator forgets to turn the spindle on, only rapid traverse (G0) moves are executed. If a block contains a feedrate motion command, operation is stopped and a **SPINDLE NOT ON, CANNOT CUT** message is displayed in the **EVENT STATUS** window.

At the end of a run, a program M2 command resets the part program text pointer to the first programmed block. Actuate START to re-run the program.

NOTE: The program can be interrupted at any time by pressing the HOLD key. The program can then be

resumed without error by actuating START.

Resuming operation after power to the drives has been disabled

If the EMERGENCY STOP button is pushed, or power fails during part program execution, or if a motion takes place which causes a travel limit switch to be reached, program execution stops, power to the drives is disabled, and the system is cleared except for the contents of the XYZ offset registers, tool data and partprogram text.

To resume operation:

1. Use AXIS DRIVE ENABLE to restore power to the motors. Then use the various JOG options to move off the limit switch, if required.

2. Home the machine. Correct the problem.

3. Using the FIND command search for a convenient restart point, preferably a tool change position.

Modifying FEED

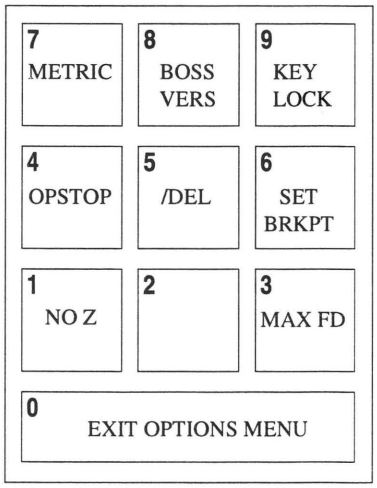
FEED OVERRIDE

Feed rates may be overridden from 5% to 150% with the FEED OVERRIDE knob. Rapid traverse rates are only modified by FEED OVERRIDE in BLOCK mode.

Enter **[3] FEED OVR** to toggle FEED OVR ON/OFF. The **SYSTEM STATUS** window indicates **FEED OVR: ON**. Rotating the JOG KNOB changes the programmed FEED. The **SYSTEM STATUS** window indicates **F,OVR %: 80** when the knob has been used to turn the override down to 80% of programmed value. The **F:** value shown in the display is the ACTUAL modified value, not the programmed value. Using the RPM JOG +/- selector switch changes the spindle speed by approximately 3% each time the button is depressed.

RUN OPTIONS

Use **[7] SET OPTION** to view the various RUN options available to be used. The display reads:



DRY RUN Options.

The **DRY RUN** options enable the partprogram to be tried out without fully running the system.

[1] **NO Z**. The partprogram can be "proven" with no Z axis movement.

NOTE: At an M6 (tool change) command the Z axis moves up to the tool change position and establishes a new NO Z plane of operation.

[3] **MAX FD**. Complete operation of the part program can be accomplished with maximum feedrate to more quickly detect programming errors.

OPERATOR RUN-TIME OPTIONS

These options allow the operator to intervene and modify how the part-program is run.

[4] **OPSTOP**. Enabling this function causes the program to STOP after executing any data block that contains an M1 command.

[5] **/DEL**. Activation of this function causes the system to ignore any instruction contained in a programmed block preceded by a slash (/).

[6] **SET BREAK PT**. The BRKPT feature is used to allow the operator to stop at a convenient point in the program. The program stops before the designated sequence number is executed. When the BREAKPOINT is reached, the System Status message indicates a Program STOP. Press START to resume program execution.

Other RUN OPTIONS

[7] **METRIC**. This option sets the system to accept all input dimensions as metric values during the operation of the part program.

[8] **BOSS VERS**. This option provides compatibility with part programs written for previous Bridgeport CNC machines using BOSS level 4 through 7 software.

Chapter 6
Edit / MDI

The BOSS SX on-screen editor provides the ability to enter and edit text. The Editor also includes a G-CODE Prompt Mode that assists the operator in the entry of partprogram data.

Both the EDIT, EDT CNC and MDI modes have the same basic functions except for the differences noted below:

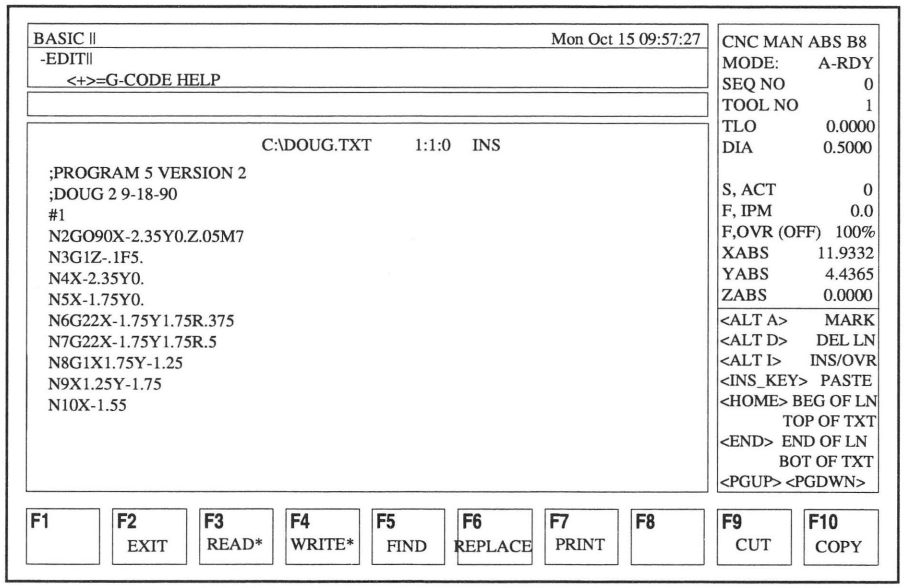
EDIT. When **[F6] EDIT** is selected from the **SETUP** screen, the operator is prompted for the file to be created or edited. The display shows the directory of all the previous files created.

EDT CNC. When **[F4] EDT CNC** is selected from the RUN menu, the last file loaded to the BMDC is loaded into the edit buffer.

MDI. When **[F5] MDI** is selected from the RUN menu, the file MDI.TXT is automatically created. As each data block is created in the G-CODE Prompt Mode, the operator is given the choice of executing the block. At the end of the MDI session the operator can choose to store the MDI.TXT file, rename the file, or exit without storing.

Commands for Editing Text

After entering the EDIT/CNC mode the display reads:



MDI: G-CODE EDIT

The bottom of the screen shows the available Editing commands:

[F2] EXIT is used to EXIT the EDIT session. The operator is given the choice of exiting with or without saving the text or saving the text in a file with another name.

[F3] READ* provides the ability to INSERT a previously saved file into the text at the current cursor location.

[F4] WRITE* provides the ability to CUT a portion of the edited text and save it in a new file.

[F5] FIND prompts the operator for a Target text. The operator enters the text to be searched for into the Target field. The cursor then is positioned at the start of the text designated as a Target.

NOTE: To find the next occurrence, shift the cursor one character to the right before using FIND.

[F6] REPLACE prompts the operator for a Target text and a Replacement text. The operator enters the text to be changed into the Target field. The new text is entered into the Replacement field. The operator is then asked if ALL instances of the Target text are to be changed, if just the NEXT instance is to be changed, or if the operator wants to scan through all instances of the targeted text and choose which ones to replace.

[F7] PRINT prints the screen. The operator is given the choice of **<1>** printing marked text or **<2>** making a screen dump.

[F9] CUT cuts the marked block to the hidden text buffer. The text that was cut is erased.

[F10] COPY copies the marked block to the hidden text buffer. The text that was copied is retained.

Additional EDIT commands are shown at the bottom of the SYSTEM STATUS display window.

<ALT A> MARK begins marking a portion of the text for use by the CUT or COPY commands. The cursor control keys are used to mark the rest of the block.

<ALT D>DEL LN deletes the current line which the cursor is on. The cursor need not be at the beginning of the line.

<ALT I>INSERT Toggles between the INSERT and OVERWRITE character input modes.

<INS KEY>PASTE pastes the text that was written to the hidden text buffer at the current cursor location. PASTE can be used any number of times— each time it is used the contents of the hidden text buffer are pasted at the current cursor position.

<HOME> Depressing HOME the first time sets the cursor at the start of the line. Depressing HOME again sets the cursor at the top of text.

<END>. Depressing END the first time sets the cursor at the end of the line. Depressing END again sets the cursor at the end of text.

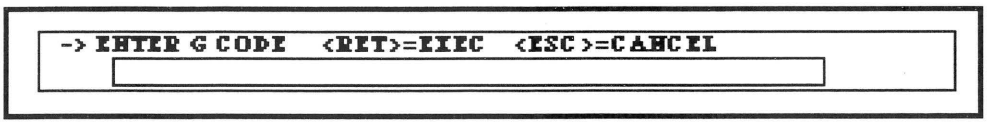
<PGUP> Displays the previous page of text.

<PGDN> Displays the next page of text.

UP/DOWN/LEFT/RIGHT ARROW. Moves cursor up/down a line or left/right a space.

Direct MDI Input

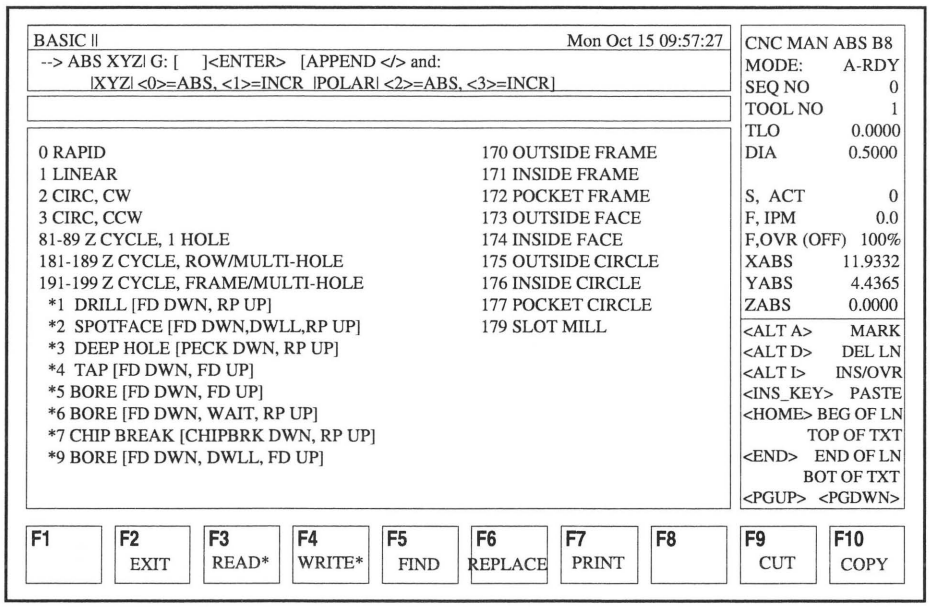
In EDI/MDI entering a <*> as the first character in a line sets the system in the MDI Input mode. The display reads:



A line of G-CODE can then be entered and executed.

Using the G-CODE Prompt Mode

In EDI/CNC entering a <+> as the first character in a line sets the system in the G-CODE Prompt Mode. The display reads:

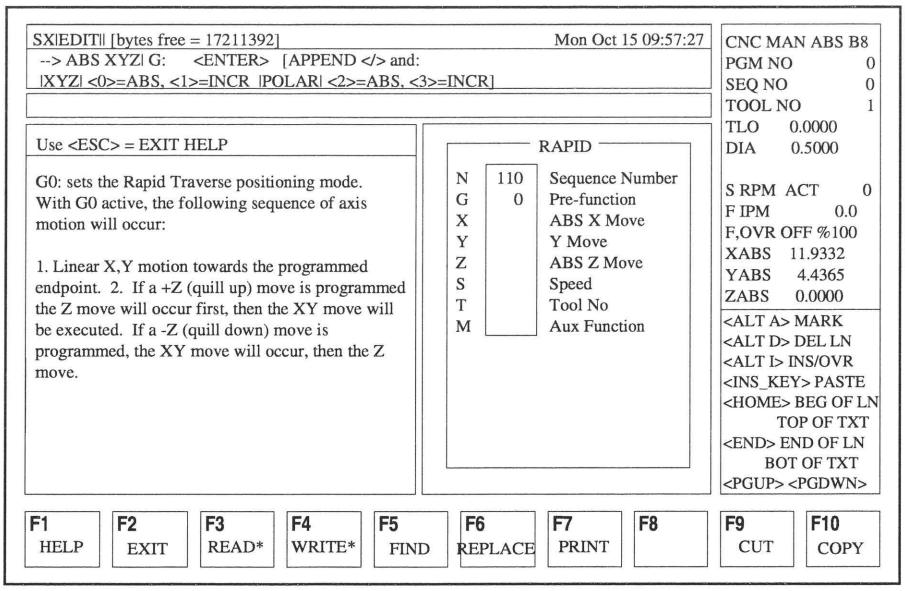


G-CODE Prompts

The G-CODE motion commands are displayed on the screen. Enter a valid G motion code in the G: field. To select Rectilinear [XYZ] or Polar motion either using ABS or INCR coordinates append </> and <0> for XYZ ABS, <1> for XYZ INCR, <2> for POLAR ABS or <3> for POLAR INCR. Once entered both the G code and Motion type commands are Modal.

The left portion of the EDIT screen now displays a table of data entry fields. Prompts give the word addresses and field descriptors for the data required for a particular G code. The Default value in the input field is the data from the previous field entered with the same G code. Entering any new data in the field blanks the field. The cursor control keys can be used to position the cursor to any field to change previously entered data. **<Enter>** can be used to skip over a field except <Enter> after the la t entry in the table which ends inputting of data and closes the table.

Press **<F1>** to display the HELP messages for the G-code being used. The screen displays:


SX|EDIT|| [bytes free = 17211392]
Mon Oct 15 09:57:27
--> ABS XYZ| G: <ENTER> [APPEND </> and:
|XYZ| <0>=ABS, <1>=INCR |POLAR| <2>=ABS, <3>=INCR]
Use <ESC> = EXIT HELP
G0: sets the Rapid Traverse positioning mode. With G0 active, the following sequence of axis motion will occur:
1. Linear X,Y motion towards the programmed endpoint. 2. If a +Z (quill up) move is programmed the Z move will occur first, then the XY move will be executed. If a -Z (quill down) move is programmed, the XY move will occur, then the Z move.
RAPID
N 110 Sequence Number
G 0 Pre-function
X ABS X Move
Y Y Move
Z ABS Z Move
S Speed
T Tool No
M Aux Function
CNC MAN ABS B8
PGM NO 0
SEQ NO 0
TOOL NO 1
TLO 0.0000
DIA 0.5000
S RPM ACT 0
F IPM 0.0
F,OVR OFF %100
XABS 11.9332
YABS 4.4365
ZABS 0.0000
<ALT A> MARK
<ALT D> DEL LN
<ALT I> INS/OVR
<INS_KEY> PASTE
<HOME> BEG OF LN
TOP OF TXT
<END> END OF LN
BOT OF TXT
<PGUP> <PGDWN>
F1 HELP
F2 EXIT
F3 READ*
F4 WRITE*
F5 FIND
F6 REPLACE
F7 PRINT
F8
F9 CUT
F10 COPY

MDI: G-CODE HELP

NOTE: The HELP information is stored in files on the system disk. Before HELP is used, the system disk **must** be inserted into the disk drive. If a User DATA disk contains the file being edited it should be re-inserted before the file is saved.

To exit the HELP screen press <ESC>.

After the data is entered in a G-code table it is displayed in the OPERATOR INSTRUCTION window as a line of G-code text. In the MDI mode, entering <1> executes the data block. Using any other key inserts the line of text in the Edit buffer at the current position of the cursor.

Appendix A
Remote Load and DNC Protocols

1.0 Establishing Communications

1.1 Program Identification Transaction

The CNC shall request that the remote device use a particular program number as the file name for the next transfer request via the following command sequence:

CNC		REMOTE
<DC2>	—> —> —> —> —>	
	<— <— <— <— <—	<DC1>
{PRGM NO}	—> —> —> —> —>	
<EOT>	—>	

Program names may be differentiated from programs in that a *name* is never more than 8 characters in length while a *program* is not less than 9 characters long.

1.2 Program Transfer Request

The following command sequences initiate program transfers between the CNC and the remote device. If a program identification transaction as described in 1.1 has not been used, the remote device should prompt for operator input via its own display and keyboard.

1.2.1 Transfer from Remote to CNC

The CNC shall request a partprogram text transfer from the remote device to the CNC via the following command sequence.

CNC		REMOTE
<DC1>	—> —> —> —> —>	
	<— <— <— <— <—	{PRGM TEXT}
	<—	<EOT>

1.2.2 Transfer from CNC to Remote

The CNC shall request a part-program text transfer from the CNC to the remote device via the following the command sequence:

CNC		REMOTE
<DC2>	—> —> —> —> —>	
	<— <— <— <— <—	<DC1>
{PRGM TEXT}	—> —> —> —>	
<EOT>	—>	
<DC4>	—>	

2.0 Transfer Record Structure

2.1 REMOTE LOAD

2.1.1 Partprogram text shall be less than 256000 characters.

2.1.2 Partprogram number shall consist of up to six numeric characters with the character string ".F" (hex 2E 46) appended.

2.1.3 The partprogram text shall be transferred from the remote device to the CNC as a one-variable length record of up to 12000 bytes.

2.1.4 Error detection shall be via Vertical Redundancy Checks (parity) performed on a character-by-character basis by the device hardware (UART's).

REMOTE LOAD RECORD FORMAT

up to 256000 bytes program text	EOT

3.0 Suspension/ Resumption of Transmission.

3.1 During transmission of the DATA portion of a record the receiving device (CNC or REMOTE) shall transmit a single "DC3" (X OFF) character to temporarily suspend data transmission and a single "DC1" (X ON) character to resume data transmission previously suspended with a X OFF character.

3.2 The transmission device shall, within 3 character times after reception of a "DC3" X OFF character, suspend further data transmission until either the subsequent reception of an X ON character or the subsequent reception of a "DLE" (cancel) character.

4.0 Error Handling

4.1 Remote LOAD Errors

Errors encountered during REMOTE LOAD shall be considered fatal and unrecoverable. Upon receiving a character with an invalid VRC bit (parity) the CNC requests that the remote device cancel transmission with the following command sequence:

CNC REMOTE

<DLE> —> —> —> —> —>

4.2 DNC LINK Errors

Error recovery shall be via re-transmission of the record in error. The CNC shall request another record by transmitting a single ACK character to request the next record or by transmitting a single NAK character to request the same record. The command sequence is as follows:

CNC REMOTE

Same RECORD
<NAK> —> —> —> —> —>
<— <— <— <— <— <DATA>
<— <— <— <— <— <ETB>
<— <— <— <— <— <LRC>

Next RECORD

<ACK> —> —> —> —> —>

<— <— <— <— <— <DATA>

<— <— <— <— <— <ETB>

<— <— <— <— <— <LRC>

4.3 Cancel Sequence

When necessary to prematurely terminate a REMOTE LOAD or DNC-LINK process the CNC shall request that the remote device cancel the current file transfer via the <DLE> (data link escape) character.

Upon reception of the <DLE> (cancel) code the remote device shall cease transmission of data, discard the balance of the file, and wait for another transfer request. The command sequence is as follows:

CNC REMOTE

<DC3> —> —> —> —> —>

<DLE> —> —> —> —> —>